THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXVII. JUNE, 1904. No. 3.

THE SYSTEM OF APPRENTICESHIP AT THE BALDWIN LOCOMOTIVE WORKS.

By S. M. Vauclain.

The success of the Baldwin Locomotive Works in dealing with their employees is everywhere known. We congratulate ourselves and our readers on being able to present this account of the very basis of this success, by so distinguished an author.—THE EDITORS.

THE technical papers have been devoting considerable space to the discussion of the labor problem from the point of view of the method of payment of labor. Many plans for bringing about a more harmonious relation between labor and capital have been suggested, the crux of these plans being the substitution, for definite rates per day, of piece work on a sliding scale, bonus, division of profit, or some similar system. None of the propositions has received the hearty approval of the workingman, and all theorizing notwithstanding, the straight day and straight piece-work system of pay find the most favor with the labor element. We have but to look back over the past two years to learn that plans of this kind have been far from successful in accomplishing their ends, for they have rather tended to separate the working man and employer by even a wider gap.

A specialist of such high repute as Carrol D. Wright has maintained that the solution of the labor problem must include some scheme of division of profit. Unfortunately, however, "Profit and Loss" are twin sisters, and the weakness of such propositions consists in the fact that they accentuate the difference between prosperous times and periods of business depression, and that they do least for the workingman during the times of most urgent need. The most

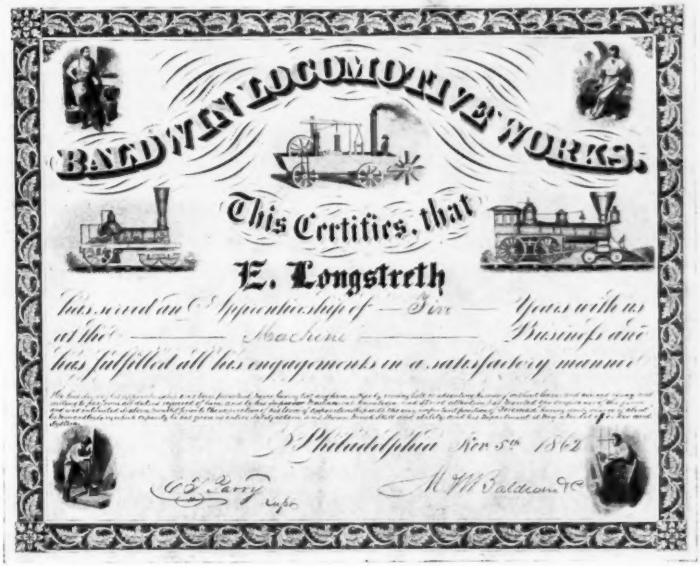
Copyright, 1904, by John R. Dunlap.

A CORNER OF THE BALDWIN LOCOMOTIVE WORKS.

pretentious plan of making business partners of the working man has been inaugurated by the United States Steel Corporation, the greatest employer of men the world has ever seen. The proposition, which is as broad and liberal as can be desired, was heralded far and wide as a panacea for labor troubles, and the employees of the company eagerly availed themselves of the opportunities offered—while the business of the company was prospering. A short year after the origination of this plan, the depression in the steel industry and the fall in the market value of the shares had a deterrent influence upon the workingmen and they were not so eager to become partners in a business in which there was even a possibility of a failure to bring future returns upon the money they might have to invest, even though the immediate returns promised a high rate of interest.

The factory which has for its cardinal principles, fair treatment of its men, the payment of an honest day's pay for an honest day's work, and which instills into its employees principles of loyalty and honesty, need have no fear of labor troubles. It is the record of the Baldwin Locomotive Works that they have never had a strike, neither do they discriminate in favor of or against the union men. The workmen know that the latch string to the head of the establishment is always out, and that any one, of whatsoever station, can secure a respectful hearing of any grievance he may have. It takes years of good faith before the workingmen can understand that principles

such as these are traditions of a plant, and if such traditions are to be kept alive they must be instilled into a sufficient number of men to form the back bone of the later element. It is a difficult matter to teach an old dog new tricks, so that the apprentices offer the most fertile field for the development of a good, loyal body of men.


BALDWIN LOCOMOTIVE WORKS.
This Certifies, that
E. Longstreth
has served an Apprenticeship of — Five — Years with us
at the — Machine — Business and
has fulfilled all his engagements in a satisfactory manner
Philadelphia Nov 5th 1862
M. W. Baldwin & Co

The four lines of fine text on the certificate read as follows: "He has during his apprenticeship ever been punctual, never having lost any time, either by coming late or absenting himself without leave, and always ready and willing to perform all duties required of him, and by his superior mechanical knowledge and strict attention has merited the confidence of the firm, and was entrusted 16 months prior to the expiration of his term of apprenticeship with the very important position of 'Foreman,' having daily charge of about 60 men and boys, in which capacity he has given us entire satisfaction and shown much skill and ability and his department is now a model of order and system."

The Baldwin Locomotive Works have always maintained a system of apprenticeship, and the certificate of Mr. Edward Longstreth (shown in illustration) who rose from the apprentice's rank to that of a proprietor, is evidence not only of the establishment of the system in the early sixties, but also as to its effectiveness. In January of 1901, however, a new system was inaugurated in which the apprentices were divided into three classes. The different classes and requirements are shown in Diagram I; the horizontal lines represent

the number of apprentices employed and the vertical lines their age and occupation, from which it will be seen that there are:—

1.—First-class apprentices, of whom there were 232 in service on the first of January 1904; they are required to have a good common-school education and are not to be over 17 years and 3 months of age. They are indentured for four years, and are required to attend a free night school for at least two evenings in each week during the first three years of the apprenticeship. The first year the apprentice is expected to take up elementary algebra and geometry, and the rudiments of mechanical drawing during the remainder of the two years.

2.—Second-class apprentices, of whom there were 99 in service on the first of January 1904. Applications for indenture in this class are considered from boys who have an advanced grammar or high-school training and who are not over 18 years of age. The term for this class is three years, and the apprentices are required to attend night school which shall teach them the rudiments of mechanical drawing for the first two years of the indenture.

3.—Third-class indenture; this is in the form of an agreement with young men of 21 years of age, who are graduates of colleges, technical schools, or scientific institutions, having courses in the higher mathematics, natural science, and drawing. They are not required to attend any night classes, but in lieu of this must read some technical journal, and turn in a synopsis of all the articles of some journal. This matter is used for indexing the articles in the publication. The indenture in each case places upon the firm the obligation to teach the apprentice thoroughly his art, and to furnish him abundant opportunity to acquire a practical knowledge of the business. The employer is also bound to retain the apprentice in service until he has completed the term provided for in the indenture, with the reservation of the right to dismiss the apprentice for cause.

The rates of pay are shown in Diagram 2; this diagram also shows how well the works discharge the obligation to the apprentice, for these statements have been compiled from actual cases and show the work upon which the apprentices are engaged for each three months of service. The photographs also show the character of the work in which the apprentices are given an opportunity to acquire skill. It will be seen that the apprentices are changed every three months, and the first-year apprentice is given experience of such an

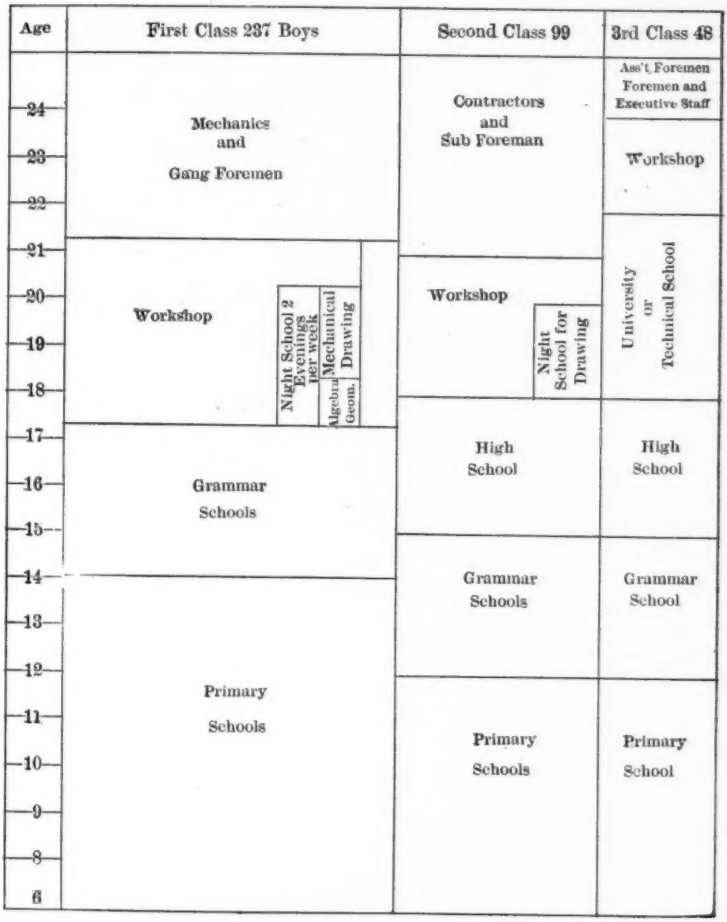


DIAGRAM I. CLASSES AND REQUIREMENTS OF APPRENTICES, BALDWIN LOCOMOTIVE WORKS.

extended character as to make him a first-class and thorough mechanic. At the end of his service he is given a bonus of $125; he is then at liberty to sever his connection with the works, and has the means of travelling half-way across the continent in search of a job satisfactory to him.

It will be seen, as shown in Diagram I, that the course for the first-class apprentices is designed to develop first-class mechanics and

the number of apprentices employed and the vertical lines their age and occupation, from which it will be seen that there are:—

1.—First-class apprentices, of whom there were 232 in service on the first of January 1904; they are required to have a good common-school education and are not to be over 17 years and 3 months of age. They are indentured for four years, and are required to attend a free night school for at least two evenings in each week during the first three years of the apprenticeship. The first year the apprentice is expected to take up elementary algebra and geometry, and the rudiments of mechanical drawing during the remainder of the two years.

2.—Second-class apprentices, of whom there were 99 in service on the first of January 1904. Applications for indenture in this class are considered from boys who have an advanced grammar or high-school training and who are not over 18 years of age. The term for this class is three years, and the apprentices are required to attend night school which shall teach them the rudiments of mechanical drawing for the first two years of the indenture.

3.—Third-class indenture; this is in the form of an agreement with young men of 21 years of age, who are graduates of colleges, technical schools, or scientific institutions, having courses in the higher mathematics, natural science, and drawing. They are not required to attend any night classes, but in lieu of this must read some technical journal, and turn in a synopsis of all the articles of some journal. This matter is used for indexing the articles in the publication. The indenture in each case places upon the firm the obligation to teach the apprentice thoroughly his art, and to furnish him abundant opportunity to acquire a practical knowledge of the business. The employer is also bound to retain the apprentice in service until he has completed the term provided for in the indenture, with the reservation of the right to dismiss the apprentice for cause.

The rates of pay are shown in Diagram 2; this diagram also shows how well the works discharge the obligation to the apprentice, for these statements have been compiled from actual cases and show the work upon which the apprentices are engaged for each three months of service. The photographs also show the character of the work in which the apprentices are given an opportunity to acquire skill. It will be seen that the apprentices are changed every three months, and the first-year apprentice is given experience of such an

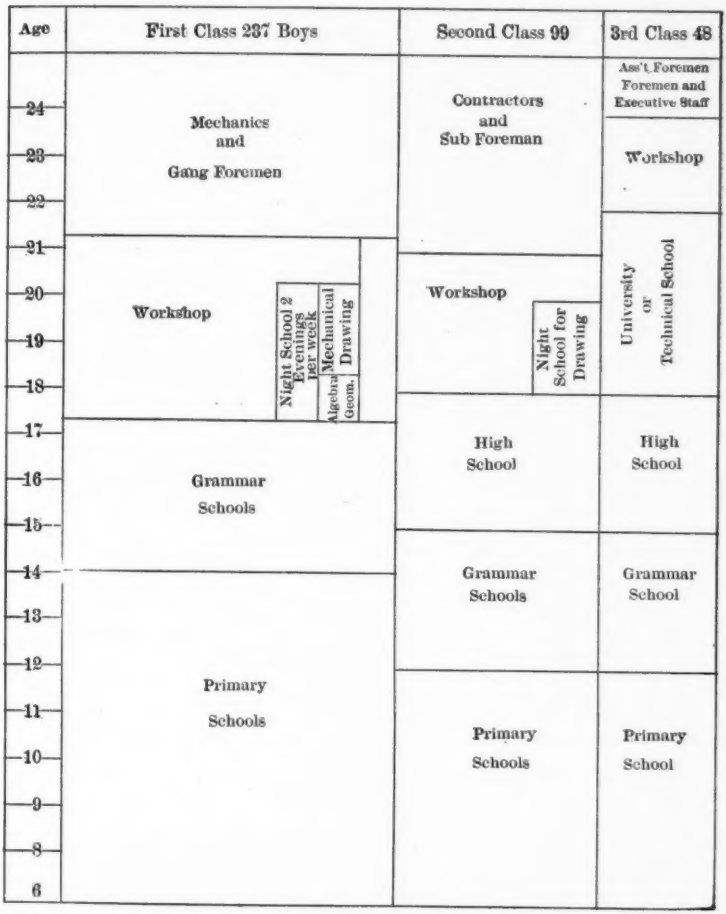


DIAGRAM I. CLASSES AND REQUIREMENTS OF APPRENTICES, BALDWIN LOCOMOTIVE WORKS.

extended character as to make him a first-class and thorough mechanic. At the end of his service he is given a bonus of $125; he is then at liberty to sever his connection with the works, and has the means of travelling half-way across the continent in search of a job satisfactory to him.

It will be seen, as shown in Diagram I, that the course for the first-class apprentices is designed to develop first-class mechanics and

men for positions of minor responsibility; the object of the course for the second class is to develop men for the positions of contractors and sub-foremen; and the assistant foremen, foremen, and executive staff, are developed from the third class of apprentices, although no limitation is placed upon the height to which any class of apprentice may aspire or rise, and the first class of apprentices may and do rise to places of higher responsibility than those held by the third class.

First Class		Second Class		Third Class	
1st Year 5¢	Planer Planer Shaper Slotter	1st Year 7½¢	Shaper Planer Lathe Bench Work	1st 6 months 13 ¢	Lathe Bench Work
2nd Year 7½¢	Slotter Bench Work Bench Work Lathe	2nd Year 9½¢	Planer Boring Mill Bench Work Bench Work	2nd 6 months 16 ¢	Planer Shaper Highway Office
3rd Year 9½¢	Test Room Planer Shaper Erecting Gang	3rd Year 11¢	Boring Cylinders Planing Cylinders Erecting Gang Erecting Gang	3rd 6 months 18 ¢	Test Department Valve Gang
4th Year 11¢	Erecting Brass Work in Erecting Shop Throttle Gang Valve Gang			4th 6 months 20 ¢	Erecting Gang Track Foreman
Bonus $125		$100			

DIAGRAM 2. RATES OF PAY OF APPRENTICES, BALDWIN LOCOMOTIVE WORKS.

It is very essential that men holding positions of responsibility should acquire a habit of making observations and keeping record of them, and in this manner develop habits which will prove very valuable to them when asked to look after the work of several men or the material required for a gang or shop. In order to systematize this work a form is provided for the second and third class of apprentices which each is required to fill in. This form contains all the data necessary to establish piece-work prices; the better class of apprentices are thus organized into an elemental rate-fixing department, and information is secured from which can be obtained a very accurate estimate of the cost of labor or of any piece of work. The superintendent of apprentices also secures a very accurate knowledge of the work being done by each apprentice and a means for comparing the work of the different apprentices.

The management carefully guard against any tendency towards paternalism, in an effort to bring out the individual qualities of the apprentices, and with the belief that the apprentices will develop into better and stronger men if they are compelled to rely upon their own resources. There are no special lectures and no clubs or social features; the blue overalls level all social distinction; princes and sons of men of wealth work shoulder to shoulder with those less favored, and it is such an everyday experience as to call for no comment.

Since January 1st, 1901, at which time the present system of apprenticeship was inaugurated under the supervision of Mr. N. W.

No.____

Machine Inspection

Shop_____ Foreman_____ Machine_____ No._____ Date_____

Contractor_____ Class of work_____ Card_____

Material_____ Engine_____

Operation	Size of tool	R. P. M.	Feed	Depth of cut	Speed	Total time	Average time	Minimum time

Remarks:

Tool steel used Apprentice_____

DATA SHEET TO BE FILLED IN BY SECOND AND THIRD-CLASS APPRENTICES.

Sample, there have been indentured five hundred and forty-five apprentices; three hundred and fifty-two first-class, one hundred and twenty-four second-class, and sixty-nine third-class. Of this number one hundred and fifty-three, or about 28 per cent., have been discharged for reasons other than expiration of their terms of apprenticeship. The total number of apprentices carried on the shop rolls at the close of the year 1903 was three hundred and seventy-nine, of

AT WORK IN THE BRASS SHOP.

MOULDING CYLINDERS IN THE FOUNDRY.

which number three hundred and forty-five are machinists, five blacksmiths, five brass finishers, ten moulders, twelve pattern makers, one boiler maker, and one sheet-iron worker. There are two hundred and thirty-two first-class, ninety-nine second class, and forty-eight third-class.

In addition to indentured apprentices there are twenty-three special apprentices, largely from foreign countries, one being a native of Finland, one of Costa Rica, two of San Domingo, five of Cuba, one of Spain, four of Japan, three of Porto Rico, and one of Mexico.

THE BLACKSMITH SHOP.

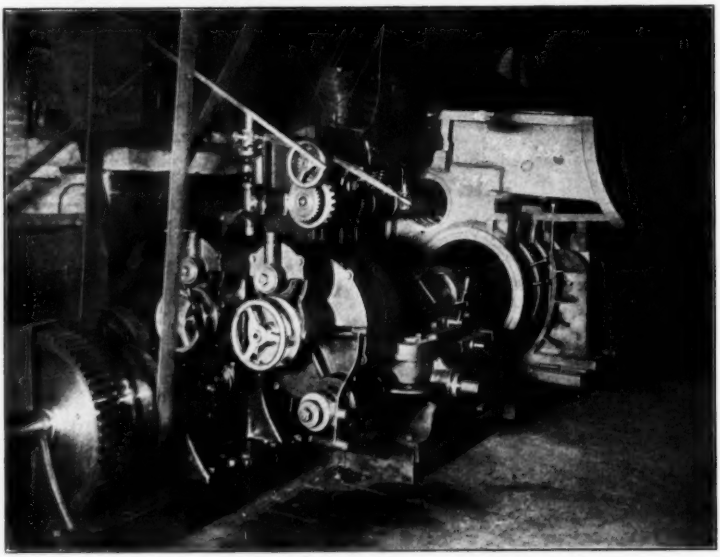
The number of apprentices indentured during the year 1903 was one hundred and sixty-five; of this number one hundred and fifty-six were indentured to the machinists' trade, five to the trade of pattern making, one to brass finishing, one to moulding, and one to boiler making. There are ninety-seven first-class, forty second-class and twenty-eight third-class. There have been sixty-one apprentices discharged during the year and thirteen dropped from the rolls by reason of expiration of apprenticeship.

Two apprentices in the first class completed their terms during the year. Both are exceptionally good hands, and at the expiration of their time were employed as machinists. Eleven apprentices in the

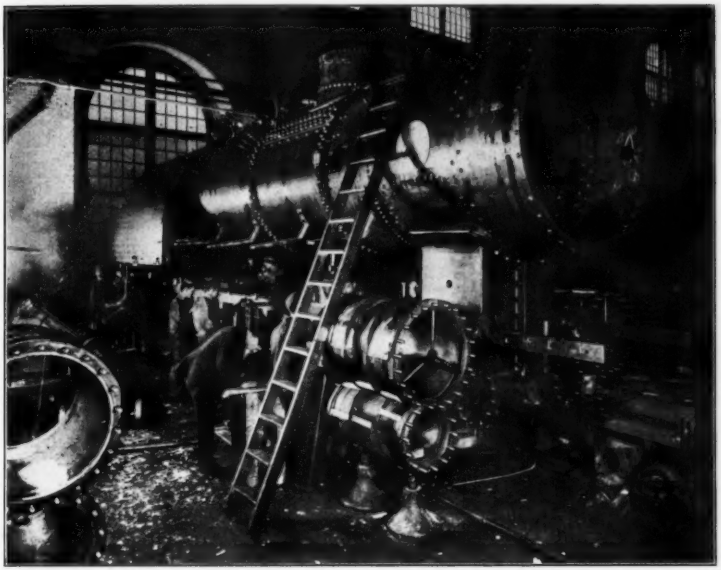
third class completed their terms during the year; six of this number have been promoted to places of responsibility in the erecting and machine shops and in the maintenance department; five others are employed as machinists in the erecting shop.

During the year 1904 fifteen first-class, thirty-one second-class, and nineteen third-class apprentices will complete their terms of apprenticeship. The attendance of the apprentices at the second term of the school year, commencing January 5th, and ending February 25th, 1903, was 63 per cent. of all the first and second-class boys on the rolls at the opening of the term, and it is expected that the percentage of attendance for the present year will be even greater.

These figures show that the Baldwin Locomotive Works are doing their share to prevent "race suicide" of the trades worked upon in their establishment. It will also be seen that the plan is not altogether a philanthropic one, for the incorporation of the several features mentioned before make the system self-supporting. The chief advantage, however, is the development of a loyal, brainy set of men with a thorough training in the mechanic arts and especially developed in certain lines. Those of them that remain will lend their energy to assisting and building up the business of their employers, and are



BORING CYLINDERS. THE TWO CYLINDERS AND THE VALVE CHEST OF A VAUCLAIN COMPOUND ARE BORED AT ONE OPERATION.

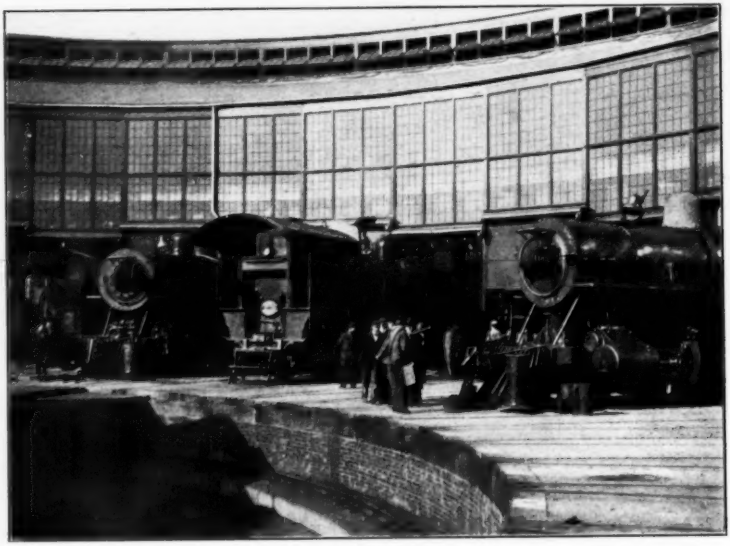


A THIRD-YEAR APPRENTICE IN CHARGE OF A GANG LINING UP AN ENGINE.

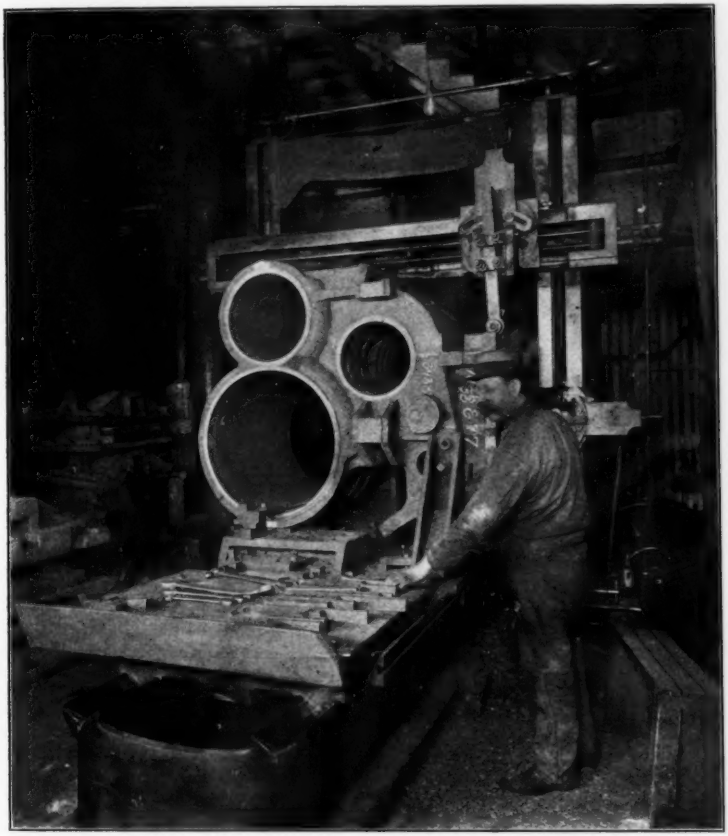
just as proud of the works and its accomplishments and just as jealous of its reputation as the proprietors themselves, for they consider themselves the children of the works. The manufacturing plant that has a loyal, intelligent body of workmen who make their employers' interest their own, has the very best equipment for meeting the strenuous competition of the present day. Mr. George S. Morison sums up the situation in "The New Epoch" as follows:

> "The profits of the new epoch must be made, not by buying cheap and selling dear, but by reducing the cost of production. The most successful man will not be the one who has the shrewdest salesman to dispose of his goods, but the one who can manufacture his wares more cheaply than any one else engaged in the same work. The most successful transportation line will not be the one whose agents are the most active in securing business, but the one which is the most closely handled, which can carry its freight at a less cost to itself to any competing line. Permanent success will depend not on commercial drummers, but on the engineer; not on the shrewd guesses of the so-called business men, but on the accurate knowledge of the manager who knows what his tools are, who knows what it costs to produce, who knows the defects of his plant and the features in which it may be improved, who, in fact, is applying all the intelligence of an educated mind, not to getting the better of some other man who may know a little less, but to getting the best work possible for himself and his employers out of what he has to work with."

THE FITTING-UP FLOOR OF THE BOILER SHOP.



IN THE ROUND HOUSE.



PLANING THE CYLINDERS OF A VAUCLAIN COMPOUND.

With the keen competition of today, in order that a manager may manufacture goods more cheaply than his competitor, he must have men in his employ of the best intellect, of the greatest industry and persistence, and loyal to him and to the business he represents. What better method can be adopted to secure these results than by training young men with a view of developing the very qualities that you desire?

Many of the young men will leave, but they will always look back to the works as to their home, and by their accomplishments will reflect credit on the works which trained them.

THE GREAT NORTHERN AND CITY RAILWAY—LONDON'S LATEST "TUBE."

By Herbert C. Fyfe.

A short time since—in December, 1903—we published an account of the Metropolitan Railway of Paris. In view of the stimulation of interest in rapid transit which will attend the approaching opening of the New York Underground (destined probably to be one of the busiest lines in the world) we have arranged to bring out during the summer illustrated descriptions of three great city systems—the London tube, the Berlin combined overhead and underground, and the New York subway. To this first of the group a sad interest is attached by the very recent death of the author, leaving this last work perhaps somewhat less finished than it might have been had he lived to revise and supplement it on its way through the press.—THE EDITORS.

SINCE the opening of the first London "Tube" railway—the city and South London—in November 1890, many important improvements in this branch of engineering have taken place.

Four tube railways in the metropolis are open, and three more are now in various stages of construction; it may be of interest to point out the general distinction between this type and the "cut and cover" or other subways of New York, Boston, and the cities of the Continent, and the ways in which the newest tube differs from the three earlier lines in the London clay.

The Great Northern and City Railway will eventually extend from Finsbury Park to Lothbury, a distance of 3¾ miles. The Finsbury Park and Moorgate Street section has recently been opened for public service. The line is of peculiar interest in that its tunnels are of greater diameter than those of any tube heretofore built; that for the first time the "composite" tunnel has been employed; that the ventilation is much better, the coaches wider and the fire precautions greater than in any tube railway previously constructed. Again, two collector rails are supplied for the first time on any London railway. The sizes of the various London tunnels are shown in the following table:—

Tube.	*Internal Diameter of Tunnels.*
City and South London	10 feet 6 inches
Central London	11 " 6 "
Waterloo and City	12 "
Great Northern and City	16 "
Waterloo and Baker Street	12 "
Charing Cross and Hampstead	12 feet 9 inches
Great Northern and Brompton	12 " 9 "
Metropolitan District	25 feet

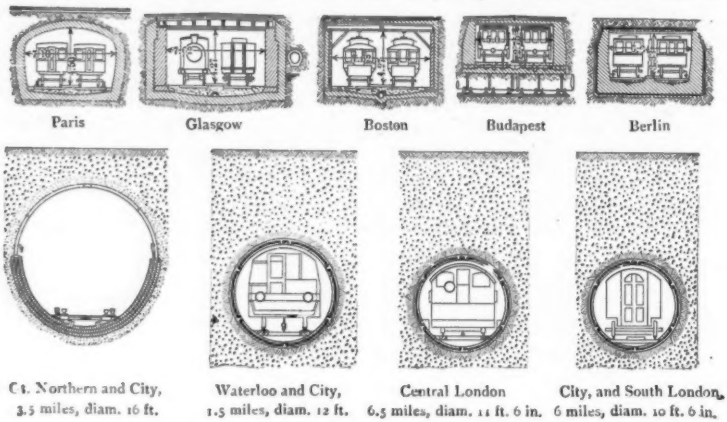
TUNNELS AT DRAYTON PARK, WHERE THE LINE OF THE GREAT NORTHERN & CITY RAILWAY COMES TO THE SURFACE.

It is interesting to note that when the Great Northern and City scheme came before the joint committee of the two Houses presided over by Mr. Standfield in 1892, the promoters were proposing to carry forward the ordinary surface Great Northern trains from Finsbury Park to Moorgate Street in the tube. At this time it was considered advisable that no new tube should be sanctioned unless its dimensions allowed the passage of main-line rolling stock. The tunnels of the Great Northern and City Railway are amply sufficient for the standard main-line carriages of the Great Northern Railway, but the promoters have abandoned their original idea and have made the terminal at Finsbury Park, 50 feet below the Great Northern metals.

Ventilation.—The wide tunnels of the Great Northern and City Railway should do much to render the air more pleasant than it is on the tubes now open. The question of ventilation has been much to the fore of late.

The public health committee of the London County Council has recently reported on the condition of the atmosphere of the Central London Railway, while others have at various times submitted it to be analysed. While these reports do not give cause for much anxiety, it is evident that something might be done to make the air more

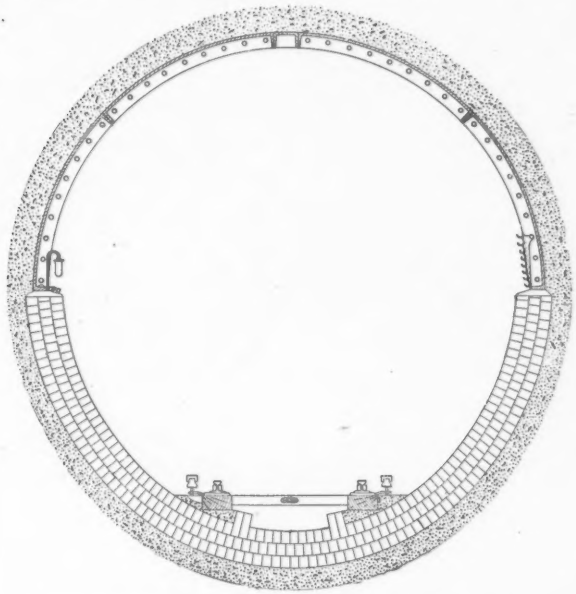
pleasant and to get rid of the peculiarly sickening atmosphere which encounters the traveller. The Central London Railway Company are establishing a huge electrical fan at Shepherd's Bush, which they expect will exhaust all the foul air in the tunnels in a very short space of time. At Bond Street station a powerful fan has lately been placed at the base of the lift shaft, which under ordinary pressure removes the vitiated atmosphere from the tunnels, fresh air taking its place at the various inlets. This fan is 48 inches in diameter and is electrically driven; it displaces 30,000 cubic feet of air per minute, and is capable of entirely exhausting the tunnels in a fraction over 3 minutes. The fan is worked every night after service hours.


Paris
Glasgow
Boston
Budapest
Berlin
Gt. Northern and City, 3.5 miles, diam. 16 ft.
Waterloo and City, 1.5 miles, diam. 12 ft.
Central London 6.5 miles, diam. 11 ft. 6 in.
City, and South London, 6 miles, diam. 10 ft. 6 in.

THE UPPER LINE ILLUSTRATES SOME OF THE MORE IMPORTANT CUT AND COVER TUNNELS; THE LOWER, THE PRINCIPAL LONDON "TUBES."

The Composite Tunnel.—For the first time in the history of tube construction, the tunnels on the Great Northern and City Railway are of "composite" construction. So far all have been made of cast iron; but in the present case Mr. E. W. Moir, M. Inst. C. E., has devised a "composite" tunnel, viz., cast iron and brick, from which great things are expected, as it is believed that it will greatly diminish noise and vibration and will give a more substantial and a less elastic construction and consequently less vibration than is found in the other tubes. The multiple-unit system of traction which is being adopted on all electrical railways—whether underground or on the surface—will of course do much towards diminishing vibration. Originally, on the Central London Railway, electric locomotives were used. These brought about vibration which was felt in houses above

the tube, but the locomotives have been superseded by motor and trailer cars. The City and South London is now the only tube which still retains its electric locomotives.



16-FOOT COMPOSITE TUNNEL, GREAT NORTHERN & CITY RAILWAY.

In the first part of the work executed, the tunnels were lined with iron, built up in segments 1-inch thick, with eight segments to the circle. These segments are 20 inches broad, measured in the direction of the length of the tube, and are bolted together through their inwardly projecting flanges by five 1-inch bolts on the sides and three 1-inch bolts on the ends. A key plate 12 inches wide is used at the top, and the space between the segments and the clay wall is filled in with lime blown in while in the liquid form, on the system devised by the late James Greathead, inventor of the Greathead shield.

After about 4,000 feet in each tunnel had been constructed in this way, Mr. Moir, of Messrs. S. Pearson and Son, Ltd., the contractors, decided to adopt the "composite" system, in which only the top half is lined with cast iron, the lower half being built in with a special brickwork in Brindle brick. A cast-iron bearer plate is placed on the line of contact between the iron lining and the brickwork, so

AN INTERIOR VIEW OF THE TUNNEL, SHOWING A STATION PLATFORM.

as to distribute the pressure evenly over the section face of the brick, the brickwork is 15 inches thick and the bricks are capable of sustaining a pressure of 400 tons to the square foot.

Vibration.—The Board of Trade committee which enquired lately into tube vibration, called attention to the fact that in consequence of the small diameter of the tunnels on the Central London Railway (11 feet 6 inches), the fit was too close, and the consequent pressure in front of the trains necessitated greater power to overcome it.

The original "gearless" electric engines on the Central London Railway weighed 44 tons, the newer geared pattern 33 tons, while the motor cars now in use weigh only 20 tons.

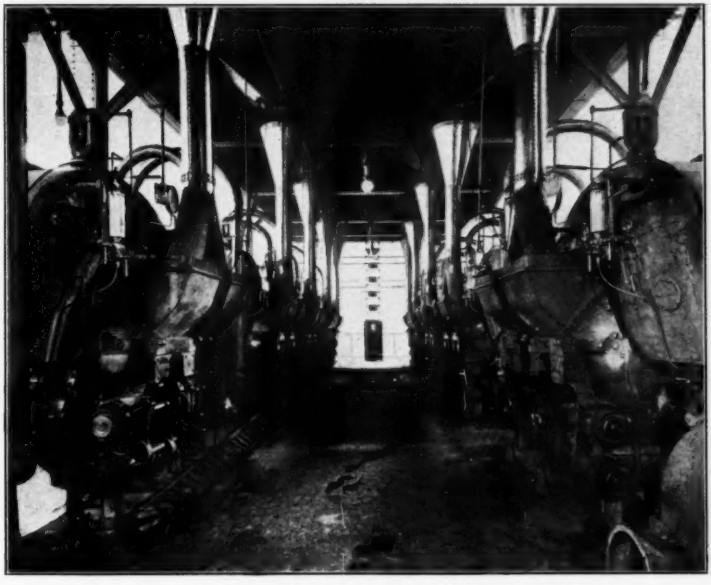
Station Tunnels.—The running tunnel is throughout 16 feet in diameter, but the station tunnels are bigger. The biggest are at Moorgate Street, viz., 23 feet in diameter and 475 feet long. All the other station tunnels are 21 feet in diameter and 420 feet long.

The Shields.—So far back as the year 1818, Sir Mark Isambard Brunel, when engaged on the construction of the old Thames tunnel between Rotherhithe and Wapping, designed "shields" in order to get rid of the timbering then considered necessary in tunnelling.

Brunel's shield was of iron and it was pushed forward by means of screw jacks; platforms were provided on which the men could walk at different levels; the face and roof were supported during excavation, and the brickwork of the tunnel was built up in the rear.

The modern shield is worked on much the same principle, but of course it is a much more powerful and effective appliance. Its advantages are that the proper size and shape of excavation are secured and that the workmen are never exposed to the risk of an unsupported roof. The shields now used in tube railway construction are structures of steel, cylindrical in shape, provided with cutting edges in front. They are forced forward by powerful hydraulic rams, and are made in sections which are taken down the shafts and put together at the bottom.

The 17-foot 3-inch Shields.—The shields used for making the 16-foot running tunnels on the Great Northern and City Railway are 17 feet 3 inches in diameter, and are noteworthy in that the hydraulic pressure used (over 2½ tons per square inch) was greater and the rams were more numerous, more powerful, and of considerably larger diameter than hitherto used in tube construction.



BOILER ROOM, SHOWING THE VICARS MECHANICAL STOKERS.

The cylindrical shell of the 17-foot 3-inch shield was composed of half-inch steel plates rivetted together, with flush heads outside. It was built in six sections; its length from cutting edge to rear is 8 feet 9 inches. Round the cylindrical front are mounted ten heavy cast-steel cutting edges, and one horizontal and two vertical bulkheads, reinforced by angle irons, serve to stiffen the structure. The horizontal bulkhead projects about 6 inches beyond the cutting edge and so helps to prevent any subsidence of the clay. The shield is

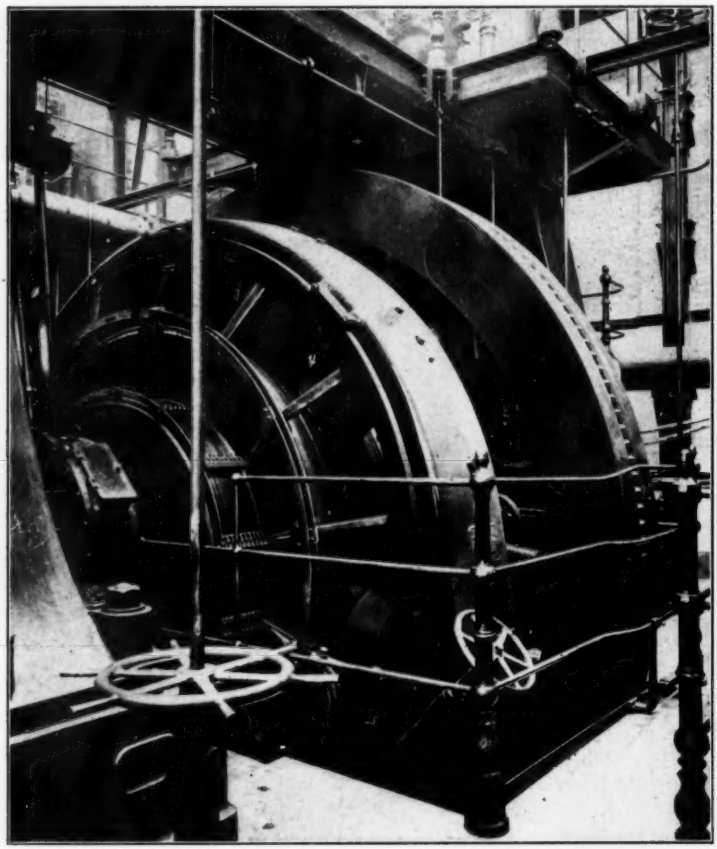
POWER HOUSE, GREAT NORTHERN & CITY RAILWAY.

divided into six compartments, each 4-feet wide, in each of which a man works on the face of the clay.

It is pushed forward by sixteen hydraulic rams or jacks, each bored out of solid ingot steel and 7 inches in diameter. The pressure has been as great as 2¾ tons to the square inch; the rams exert their pressure directly on the back of the cutting-edge castings, and the purchase is taken off the edge of the erected tunnel segments nearest the shield. Before each "shove" the men excavate the clay with pick axes and cut grooves in the face to a depth of some 18 inches; the shield is then driven forward, and the excavated material is carried away on trucks hauled by ponies and sent up the nearest shaft. The jacks are connected up the back to the hydraulic service, and the controlling valves are worked from one point on the back.

THE MAIN SWITCHBOARD IN THE POWER STATION.

Station Shields.—The station shields are of two types. In the case of the Moorgate Street station they are 24 feet 8½ inches in diameter and 9 feet 6 inches in length, with two vertical and two horizontal bulkheads, giving nine working compartments, and are provided with twenty-four 8-inch hydraulic rams. The shields used for other stations are 22 feet 10 inches in diameter.



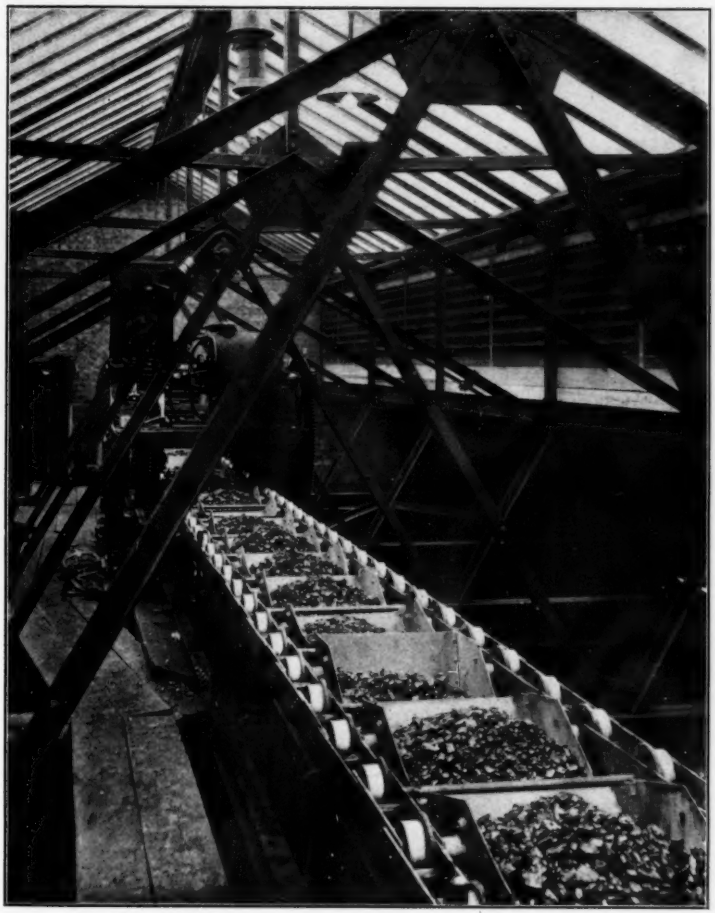
ONE OF THE LARGE GENERATING UNITS IN THE POWER STATION.

The London Clay.—In making the Central London Railway the London clay was met with 29⅛ feet below the surface. It ran almost without a break between the Bank and Shepherd's Bush, the only gap being at a point between Red Lion Street and Berner's Street, where the Woolwich and Reading strata cropped up, consisting of hard red streaky clay, beds of white sand, and limestone rock.

The depth of the tubes varies considerably. At the Bank the Central London Railway is 65 feet below the road; at Notting Hill Gate 100 feet. In some places the Charing Cross and Hampstead tube will be from 120 to 216 feet below the surface.

The Erector.—A hydraulic crane is employed for placing the cast-iron segments of the tunnel lining in position. In the case of the 16-feet tunnels, one erector was used for erecting the cast-iron segments of the rings; but in the case of the larger shields two were used.

The erector is attached to the back of the shield at the centre, so that its arm can sweep the whole periphery of the circle, whilst there is also an extending and contracting motion radially; in the case of the smaller one the rotating motion is worked by means of a rack and



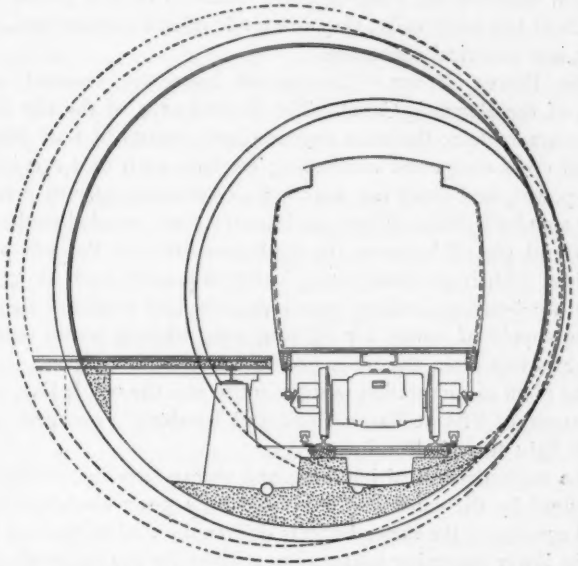
HUNT COAL CONVEYOR, OPERATED BY BRITISH-THOMSON-HOUSTON MOTOR.

CANAL AT THE POWER HOUSE; HERE COAL IS UNLOADED BY MACHINERY AND DELIVERED TO HUNT CONVEYORS, WHICH ON THEIR RETURN CARRY THE ASHES BACK AND UNLOAD THEM.

pinion, the rack being moved to and fro by means of hydraulic rams with stationary cylinders. The rack rotates the pinion about the main trunnion, and the latter is extended forward so as to form a box in which the extended arm slides, the extending motion being produced by another ram and cylinder bolted to the box.

How the Segments Are Erected.—The segments which go to make up the ring of the tunnel are built up within the tail of the

shield, which always overlaps by 1 foot 8 inches, or one cast-iron ring, the last completed portion of the tunnel, so that the clay has no chance of pushing through into the tube. Eight segments and one key piece go to make up one complete ring, and when these have been laid against the skin of the shield and bolted together, the shield moves forward, leaving an annular vacuity 4 inches in width between the back of the plates and the natural ground. This space is made solid by the injection of a grout under pneumatic pressure.



TRANSVERSE SECTION OF 16, 21, AND 23-FOOT TUNNELS, SHOWING ROLLING STOCK, PLATFORMS, AND PERMANENT WAY, GREAT NORTHERN & CITY RAILWAY.

Rolling Stock.—The multiple-unit system will of course be employed; each train will consist of seven cars, three of which will be motors and four trailers. It is proposed to run a three-minute service of seven-coach trains, and the single journey will be made in some 13½ minutes, including three intermediate stops of 20 seconds each. The acceleration will be about 2 feet per second per second. Each train when fully loaded will weigh 200 tons, and each will seat about 500 persons. Each motor car is fitted with two 125-horse-power motors, and each can seat 58 passengers; the trailers accommodate 62. The maximum speed will be 33 miles an hour.

The cars are 49 feet 6 inches long and 9 feet 4 inches wide; fireproof compartments are fitted at the end of the motor cars for the reception of the electrical equipments. The trains are equipped with the Westinghouse quick-action brake. The motors are being supplied by the British-Thomson-Houston Company, and the British-Thomson-Houston master-control system will be used; they weigh 4,280 pounds and are rated at 125 horse-power. The current is picked up by a shoe attachment from a third positive rail, the return being through a fourth negative rail; one of these insulated rails is placed outside of each of the track rails; they are made of low-carbon steel, having a very low electrical resistance.

The Power House.—The power house is situated on the banks of the Regent's Canal. The ground area of the site is about 22,500 square feet; the main engine plant consists of four Musgrave vertical cross-compound condensing engines, each of 1,250 indicated horse-power, and there are four main continuous-current generators of the standard British-Thomson-Houston type, coupled to the engine shafts and placed between the high-pressure and the low-pressure cylinders. Their nominal rating is 800 kilowatts each at 575 volts. There are besides auxiliary steam engines and auxiliary generators for the supply of power for lighting, etc., when it is not convenient to take power from the main generators for this purpose.

The plant at this station is sufficient to run the whole line, to work the passenger lifts at Essex Road and Finsbury Pavement stations, and to light the whole railway.

The methods of coal handling and storage are interesting. Coal is brought by the canal and is hoisted by a 5-ton electric crane into a coal conveyor; the upper buckets deliver the coal to the coal bunker and the lower returning buckets are utilised for the removal of ashes, which by means of a shoot are delivered into canal barges. From the bunker the coal is fed by shoots into mechanical stokers of the Vicars type; the stokers are driven by two electric motors, placed at the end of the boiler house, each capable of driving the whole of the stokers.

As to the progress of the work, a maximum speed has been attained of erecting 44 rings of the segments, completely bolted together and "grouted," during the week of 5½ days. The average is 35 to 40 rings a week. At each forward move some 20 inches progress is made through the clay, and the average daily distance traversed by the shield is 8 to 10 feet.

THE PREMIUM PLAN OF WAGE PAYMENT IN A REPAIR SHOP.

By Albert W. Thompson.

IN the preceding issue of this Magazine I described the shop-statistics and cost-keeping system in use in the shops of the Amoskeag Manufacturing Company, in which the principal business is repairs and the work presents a great variety of detail. It remains to review the methods which have been used in adapting the premium plan in the same works.

Bonus and premium systems of rewarding labor, while they attain a high state of efficiency in manufacturing shops, are not readily adaptable to ordinary repair work; and therefore the ordinary or day-rate system is used in this shop. Many cases occur, however, in building new machinery or in extensive alteration work, where duplicate parts are produced in quantity sufficient to offer good opportunity to apply the premium system, and it has gradually been introduced without in any way disturbing the prevailing system, and with very good results. To illustrate the application to alteration work, let us suppose that several hundred ring-spinning frames in one of the large mills are to be equipped with an improved type of spindle, necessitating changes in various parts of the frames, such as lowering the spindle rails, putting in new lifter rods, hangers, etc. The shop foreman who has charge of all spinning repairs organizes an adequate gang of men under a capable sub-foreman, after getting on hand enough new parts to insure continuity of work, and commences the change, giving the work the closest attention possible for a few days. At the end of a week the men are well organized and their capacity can be pretty closely gauged. Let us suppose that ten frames have been changed. Allowing for "hitches" incidental to the start, we estimate that at least twelve frames can be changed per week under ordinary circumstances, i. e., day-rate. We offer the men, then, "half time extra on all frames above twelve per week." This means that they are considered able to do twelve frames per week, or two per day, equivalent to one half a day per frame, and that for all accomplished above that rate they are entitled to one half the time saved, or a quarter of a day's pay for

each additional frame. This method has always given good results, as the estimates have been fairly made, and the men in consequence do their best and earn good wages. The men practically organize themselves, and if there are any laggards in the gang they are at once detected and replaced by better men. Under this system there is no opportunity for slighting the work in the effort to increase earnings, for such gangs are always managed by a reliable sub-foreman who is held responsible for the work and who permits no shirking. Cut-downs have never been made on the original rates, as experience proves that the first few days' work forms a reliable basis for fair estimates.

In the machine shop, where a man is to be started out on premium work, two different methods of estimating are used. If the operations are short and simple, the foreman or second hand finishes a few pieces, timing his own performances. If a relatively long time is required for each piece the foreman or second hand determines the feeds and speeds to be used, and a man is at once started on the work. He is watched by the foreman or second hand with sufficient care to detect any hanging back, which, if it is suspected, is liberally discounted in the estimate which is made with the result of his first few hours' work as a basis. As the rate finally applied dates from the time when the work commenced, and as most of these jobs last for a few days only, the workman himself is usually the principal loser by any attempt at deceit, since he loses production and in all probability has his rate discounted. When the work is to be of long duration the importance of accurate estimating is increased, and the former of the above methods is used. If improved tools or jigs which make an increased output possible, are introduced during the course of the work, the rate is modified, but only to a point which allows the workmen to profit by it to a reasonable extent, thus removing any tendency of the workmen to oppose improvements and encouraging them to suggest them. Cut-downs are almost never made, for although all contracts are made for one payment only, it is considered better policy to allow a man to earn a high compensation for a few days than to run the risk of arousing the spirit of dissatisfaction and sullen opposition which is sure to follow the practice of cutting rates. When machinery operations are relatively brief and handling operations relatively long, the bonus rate is usually fixed at about one half of the production rate, since it is in these cases that the greatest gains are made in production, simply by increased attention to business. If, on the other hand, the machinery operations are relatively long and handling relatively short, the bonus rate is increased, as small gains represent more effort than in the

former case. It should be noted that this method offsets to a certain extent the danger of too lenient estimates, as in cases where the estimate is based on the performance of a man who has handled his work slowly, it is difficult for him to increase his output to a point where his earnings become unreasonably large, on account of the low bonus rate.

Figures 11, 12 and 13 show the forms used for the original contract record, the inspector's record, and the workman's contract card. The clerk who inspects all premium work also assists the foremen in making and recording contracts, all records of which are filed in the shop office on the day when they are made, as shown in Figure 11.

Contract No. 93-1
Name James Nixon
Terms 62 minutes
Bonus 31 "

CH.	DATE	TIME	PIECES	CH.
○	Jan. 18	10-20	15	⇔
○	" 19	10-20	15	⇔
○	" 20	10-20	15	⇔
○	" 21	10-20	15	⇔
○	TOTALS	41-20	60	⇔

PRESERVE THIS CARD

FIG. 11. ORIGINAL CONTRACT RECORD.
The original card is 3½ inches wide and 5¾ inches high.

The production rate is the time, usually stated in minutes per piece, which the workman must excel before any premium is earned. The bonus or premium rate is the premium earned, also stated in minutes per piece, on each piece produced above the number called for by the production rate. Where a contract is made and work begun the foreman gives the workman his contract card, upon which are entered the terms of the contract, its number, and the time when work begins. The workman keeps his own count of work produced and enters the time worked on this card and also on his regular time card. Each morning the inspector—who has previously inserted an inspector's record (Figure 11) in the record book which he carries, each sheet of which corresponds to a contract in operation—visits all men employed on contract

Amoskeag Manufacturing Company

Payment Ending Jan. 30. 1904.

Workman's Name James Nixon Pay $ 1.85

Production Rate, per piece 62 minutes

Bonus Rate, per piece 31 "

DATE.	TIME.	PIECES.	DATE.	TIME.	PIECES.
Jan. 18	10-20	15			
" 19	10-20	15			
" 20	10-20	15			
" 21	10-20	15			
TOTALS.	41-20	60	TOTALS.		

Total Time, hours 44½

Total Pieces Required 40

Pieces Subject to Bonus, per cent 50 Total 20

Total Pieces Made 60

Time Allowed, hours 10¼

Bonus Earned, per cent 25

Earned, per hour 23.1 ¢

" per piece 15.9 ¢

Time per piece, minutes 41½

Signed ~~~~~ Inspector.

Inspector's Record, Contract No. 93-1

FIG. 12. INSPECTOR'S RECORD.
The original is 5½ inches wide and 8¼ inches high.

work, counts and inspects their work and cards, and enters results on his record sheets. He is followed by a man who removes all work produced to the painting floor or to the next department where work is due. In cases where successive operations are required in the same department, the work is required by be prick-punched or stamped after counting, thus preventing recounting. After visiting the men the in-

Amoskeag Manufacturing Company

DESCRIPTION OF WORK

Chucking, reaming turning & finishing Spreader Bolsters, for Biddeford Spreders.

Dia of hole after reaming, 3/4". Dia of outside surface after turning 1/4"

Workman James Nixon *Pay, $* 1.85

Production Rate, per piece 62 minutes

Bonus " " " 31 "

Foreman's Signature

PAYMENT ENDING	TIME	PRODUCTION			EARNED		TIME
	Hours	Required	Actual	Gain	Per Hour	Per Piece	Per Piece
Jan. 30, 1904.	41 1/3	40	60	20	23.1¢	15.9¢	41 1/3

Output Increased, per cent 50

Earnings " " " 25

Cost Reduced " " " 16 2/3

Contract Made Jan. 16 1904

" *Expired* Jan 22 1904

Contract Record No. 93-1

FIG. 13. WORKMAN'S CONTRACT RECORD CARD.

The original form is 5½ inches wide and 10¾ inches high.

spector visits the foreman, who verifies his time records. The workman's card is punched by the inspector opposite the count entry, and by the foreman (to whom all cards are handed at night) opposite the time entry, which must check with the foreman's record. The records cannot be altered to meet any claims made after cards are punched.

At the close of a payment the inspector computes the time allowance earned by each workman, enters it on the sheet in the manner shown, and turns the sheets over to the pay-roll clerk, who adds the allowed time to the working time on the pay roll. The sheets are then returned to the inspector, who fills out the remaining blanks on the sheet and transfers the results to the original record, which is kept on an indexed file for reference.

The clerical work involved by the systems above described, including the cost-keeping and shop-statistics systems described in the preceding article last May, is readily performed by three clerks, who also have other duties not touched upon here. It is probable, however, that another clerk will soon be required, as the increasing use of the premium system will soon call for the undivided attention of one man for estimating and inspecting and the clerical work incident thereto.

In closing I would say, in regard to the cost-keeping methods, that they are here described without claiming for them any merit but that of flexibility and adaptability to the peculiar conditions for which they were designed. They would suffer unjustly by comparison with the highly developed systems in use in many manufacturing shops, where inflexibility is the great desideratum. The same statement holds true in regard to the method of applying the premium system. In a shop organized on the lines here obtaining the personal equation of the foreman is an important factor in the success of such methods, and his influence and co-operation are to be sought rather than avoided. With less than fifty contracts in operation at one time this system works smoothly, but attempted on a large scale it would soon become troublesome and a different and more scientific method of estimation would become an imperative necessity. At least, this method is a simple means for the tentative introduction of the premium system without disturbing existing conditions, and will serve until the volume of work outgrows the limited capacity to which it is restricted by its characteristics. In common with all such systems, it possesses the merit of rewarding the workman for what he does accomplish, rather than for what he is expected to accomplish.

THE REDUCTION OF FIRE HAZARDS IN ELECTRIC PLANTS

By Howard S. Knowlton.

IT is probable that the loss of property by fire this year in the United States and Canada will amount to more than two hundred million dollars. The great Baltimore conflagration and the Toronto and Rochester fires are the principal bases of this prediction. Among all the vital problems confronting civilization, it is safe to say that scarcely any single question affects the material welfare of humanity more closely than does the elimination or reduction of this fearful source of waste. Over and above any valuations of property loss stands the annual sacrifice of human life.

Industrial processes involving heat, light, and power cannot be divorced from all hazards of fire. This being so, the duty of every engineer is plainly the reduction of such hazards to the lowest possible amount. The mechanical phases of electrical construction are today greatly superior in point of workmanship, thoroughness, and security to the work of ten years ago. This applies, of course, to new installations, in the main. A great deal more, however, remains to be done along the line of diminishing the fire risk. It is surprising how many defective practices will stare one in the face on a tour of inspection.

The fire problem divides itself naturally into two parts:—precautions against the occurrence of fire, and the means of extinguishing the flames when once a blaze has started. It is of literally tremendous importance that the life of the most insignificant fire should be measured in seconds, and still more imperative is it that as far as human knowledge can insure, there shall be no combination of materials and circumstances capable of causing any fire whatever. The solution of the problem is, then, a matter of details.

Electric plants, like all other types of industrial buildings, call for some form of concrete, brick, and steel construction, with a conspicuous absence of wooden walls and beams, if the greatest security against external or internal conflagrations is to be attained. As an alternative, the "mill" or "slow-burning" construction is sometimes necessary, the use of wood being essential in some parts of the coun-

try. The exposure of the building to adjoining structures is also a matter of serious consideration. The use of fire shutters on all windows at the rear and sides which in any case are likely to be attacked by flames cannot be too strongly urged. Due allowance should be made for the effect of heavy gales of wind in considering the risk presented by buildings even two or three hundred feet away. Usually it will be impracticable, for æsthetic reasons, to place shutters on the front windows of plants, and often the same restriction applies to certain side windows also. An effective substitute for shutters is found in the use of wired glass windows set in metal casings. Even these windows are objectionable in many offices, on account of their non-transparency, although their diffusion properties are excellent. As a last resort, asbestos roller curtains may be fitted to the inside of the windows. These should fit the casing tightly when drawn down, and should always be provided with eyelets so that they may be fastened down at night or in times of emergency. Wooden window casings are not advisable. Every side of the electric plant should be gone over in this connection, and the roof, as well. Often a pent house or roof shack will be found to be composed of the most flimsy and inflammable material, with plain glass windows, wooden doors and casings, even though the sides may be lined with tin or sheet iron. It is a good plan to place fire shutters or wired glass in such instances where the risk is apparent. There is little excuse for the use of plain glass in roof windows and doors. Another precaution which is at times invaluable on the roof is a water faucet with a screw thread cut at its end for the reception of a hose coupling. In case sparks and brands from a nearby fire are blown upon the roof by the wind, the advantages of such a water supply are great. Some means should be provided for closing all ventilating apertures in walls which are exposed to the direct onslaught of fire. Monitors should preferably be of wired glass, as this material is practically as effective when broken in fragments as when solid, its power of holding together is so noteworthy. Shutters ought not to be fastened tightly to the walls with stout wire, as this greatly delays their closing at a time when minutes are precious, nor should they be constructed with more seams than are absolutely necessary, the experience of the Baltimore fire showing the unreliability of shutters abounding in seams. Gravel and slate roofs should always have the preference over wooden construction.

The yard and premises surrounding electric plants are often sources of considerable risk. It would seem unnecessary to point out the danger of throwing hot ashes into wooden barrels, casting refuse

paper upon ash piles, and allowing miscellaneous rubbish to accumulate in sheds and store houses; and yet this condition is in existence in countless localities the country over. The storage of gasoline is another fruitful source of fire. It is better to keep but a gallon or two around the premises at any one time, and this ought always to be held in a fire-proof can, properly marked, and fitted with a tight stop cock and cover. In every instance the oil can is safer outside the main building than within it.

In almost all telephone and telegraph offices, and in many electric-lighting and railway plants located in regions traversed by high-potential transmission circuits, the chances of fire through the crossing of low and high-voltage wires are so great as to warrant a most careful investigation of the situation by a skilled engineer. This is an outcome of the rapid multiplication of power circuits throughout the country in the development of the long-distance transmission of electrical energy at potentials ranging from 5,000 to 60,000 volts. Special overhead construction for the prevention of such crossings is now being installed at many danger points, but the work has hardly been begun as yet. A high-tension "cross" on a low-tension line may easily start fires at many widely scattered points, to say nothing of the risk to human life. Ordinary protective devices in the way of fuses, automatic cutouts, and circuit breakers are usually effective up to 5,000 volts, but beyond this potential the only safe course appears to be the absolute prevention of any contact whatever between circuits which literally carry "chained lightning" and those of lower pressure. The latest rules of the National Board of Fire Underwriters are suggestive in detail as to how to avoid these serious dangers.

The question of a water supply on each side of the building is quite as important on the ground level as on the top of the roof. The availability of a fire or garden hose long enough to reach the most distant point on the premises from every supply faucet is pre-supposed. This hose should preferably be kept on a light reel which can be easily rolled about, and should not be coiled up in some dark corner of the basement where heat or dampness will cause rapid deterioration.

If hydrants are set in the yards of plants for the protection of store houses, oil houses, etc., they should be provided with a valve below the frost line in the earth, as well as an independent outside valve on each of the hose connections.

The location of the nearest fire-alarm box should be familiar to every employee, and the practice of installing a special alarm box at the electric plant itself is worthy of imitation.

Turning to the interior of plants, we may profitably consider some of the more frequent causes of fires in the attempt to examine the means of prevention and extinguishment. It is impossible to separate these causes clearly, as many of them run more or less together. Nor can a complete list be easily prepared, but it is not difficult to present a fairly representative and suggestive summary:—

TABLE OF CAUSES OF FIRE IN ELECTRIC PLANTS.

Accumulation of combustible material such as waste, rags, paper, kindlings, shavings, greasy refuse, and dirt.

Spontaneous combustion of wet sawdust, rags, shavings, soot, coal, and decayed wood.

Explosion of gasoline, alcohol, kerosene, petroleum vapor, illuminating gas; ignition of oils; leakage of reservoirs, tanks, lanterns and pipes.

Incendiarism.

Boiler explosions; bursting of steam pipes; faulty chimney and flue construction; careless handling of ashes.

Overheated soldering torches; gas or electric heaters improperly supported on combustible bases; thawing out pipes; burning rubbish; swinging gas fixtures; absence of sheeting around stoves, hot pipes, etc.

Careless handling of matches; unsafe storage of matches; rats and matches; thoughtless throwing of cigars, pipe ashes, and cigarettes near or into sawdust spittoons, waste baskets, excelsior barrels, etc.; misuse of candles.

Belt friction, overheated bearings, stoves, pipes; heavy overloads on dynamos, motors, transformers, wiring and switchboard appliances.

Ignition or explosion of chemicals in work rooms; exhaustion of employees from overwork; boiling over of tar kettles; mixture of water with sulphuric acid in storage battery work; water coming in contact with lime in bulk.

Lightning.

Defective electric wiring and fixtures; contact of incandescent lamps with inflammable substances; grounds, short circuits, overloads, sparks from arc lamps, flashing at commutators; overheating of wires and cables.

High-potential crosses.

An examination of the foregoing causes of fire will inevitably lead to the conclusion that the greater proportion of them are preventable. Careless operation is at the bottom of most of the trouble. Unceasing vigilance of inspection is the price of security—in fact, the whole problem of fire prevention is largely one of keeping all possible hazards in mind, and watching all the dark nooks and corners.

The supply and maintenance of apparatus for the discovery and extinguishment of incipient fires deserve the closest attention. Inside an electric plant, water is of no value in putting out an electrical fire, and

for this reason automatic sprinklers are undesirable. Extinguishers of the dry powder, chemical, or compressed-gas type are far more effective for all-around service. Fires caused by electric arcs are best beaten out by asbestos or woolen blankets, overcoats, towels, etc., or else quenched by the liberal use of sand. Tanks and pails intended for fire use only are liable to become empty, and changes in partitions, store rooms, shelves, and supplies are likely to prevent efficient fire fighting, unless the inspection is regularly kept up and the hazard constantly borne in mind. A daily examination of the condition of extinguishers, pails, pumps, valves, shutters, and alarm systems may not be necessary, but it is certainly unwise to let more than a week elapse between inspections. It pays to file written reports, discussing changes in the fire-fighting equipment of the plant; unusual conditions observed; date of refilling pails, replacing or recharging batteries; results of tests, etc. The responsibility of this work should be laid upon one employee alone, and his reports should receive the attention of the superintendent or manager and not be allowed to lapse into mere perfunctory records. Chemical extinguishers ought to be discharged and refilled at least once a year. Loose wiring and frayed insulation should be repaired as soon as discovered.

The entire wiring system ought to conform to the practice of the National Board of Fire Underwriters. Special care is necessary to avoid the overheating of circuits through inadequate design; the use of unapproved fittings; and contact of insulated wires with wood or metal work. Loose ends of circuits should be taped and placed out of harm's way. In all sorts of electric plants, incandescent-lamp cord is likely to be run anywhere and everywhere with the utmost carelessness, and this constitutes a hazard of no small importance. Electric heaters should never be left in circuit, by themselves, through the noon hour or at night.

Windows and doors in attics and lofts should be closed at all times when no one is present, and all doors in the path of strong drafts of air should preferably be covered with sheet iron or tin. In case of fire, doors dividing different parts of the plant should be closed at once to prevent the supply of air and check the spread of the flames. Doors between boiler and engine rooms, for example, which are hung on inclined tracks, should be examined frequently to see if they work properly, and when it is necessary to keep them open, the use of a fusible link is good practice. Doors leading to oil rooms are safer when closed. Oily waste should never be stored anywhere when in use except in fire-proof cans or boxes with self-closing covers. Buckets

of sand with scoops, and fire extinguishers, should be placed in prominent positions throughout the plant, and not hidden away in closets, under stairways, etc.

Great confusion often arises in electric plants during fires through the station's being plunged into utter darkness by the failure of the lighting current. This is easily preventable by the use of either oil or candle lanterns, and it is the part of wisdom to provide such an alternative source of illumination in every plant. The water and gas supply, if a station is provided with the latter, ought to be equipped with valves at the entrance of the building.

An automatic fire alarm which will give warning of any unusual temperature rise beyond safe limits is a necessity in all plants which are divided into several rooms, such as telephone exchanges. Experts in fighting fires are unanimously agreed that the earliest stage of the flames is the time to put in the most effective work, and money spent for thermostat alarms is well invested. Simplicity in design and positive action are the desirable features of such apparatus. Even if a plant is constantly under the eyes of the operating force, it is a wise precaution to equip out of the way corners with some such device.

Gas engines should be fitted with automatic valves which will cut off the supply of fuel in case the engine comes to a stop, and the exhaust piping from such machines should be as free from bends as possible, and if it is not carried up special brick flues in the wall of the building, it should extend outside of the building and not discharge into a chimney. When this piping passes through wooden floors, partitions, or roofs, it should be furnished with ventilating thimbles. In order to avoid exposure to water damage, switchboard cables may be run at least four inches from the floor, and all plumbing pipes should be so installed that in case of leakage, water cannot reach any of the electrical apparatus or wires.

The entrance of very high potential wires into a power plant building or substation is a matter demanding the best engineering construction. Considerations of the striking distance of extreme voltages; possible obstructions due to animals, birds, or wind; glass thimbles, moisture and open air space, must all be carefully taken into account. Transformer connections, to be safe, must be as direct and clear as the situation will permit, and care should be taken to prevent any fire starting through the leakage of transformer oil in case of a burnout. The traveling-crane arrangements should enable any piece of apparatus to be quickly removed to a safe place in case it becomes short-circuited or otherwise damaged. Plenty of clear space around and above all

the machinery is a good plan to work toward, as far as the cost of real estate and building construction will allow.

In telephone exchanges considerable danger exists from fire caused by overheated switchboard cord circuits, or the careless use of torches around the lower part of the switchboard. It is highly advisable to install fire-proof barriers between the cord shelf and the multiple jacks, forming a continuous horizontal separation throughout the switchboard between the cabling and the cord shelf, thus protecting the cables from any fire originating below the partition. These bulkheads, as manufactured by the Bell interests, are made to be readily removable in case it is necessary to work about the switchboard.

In localities where ice is likely to be formed if water alone is used in fire pails, freezing may be prevented by the mixture of either common salt or calcium chloride with the water. The American Telephone and Telegraph Company recommends the following specific gravities:

Calcium Chloride.		Sodium Chloride.	
Sp. Gr. 60° F.	Freezing Point.	Sp. Gr. 60° F.	Freezing Point.
1090	20° F.	1065	20° F.
1140	10°	1125	10°
1175	0°	1190	0°
1205	—10°		
1225	—20°		

These solutions are corrosive, and should never be used about switchboards or other electrical apparatus except in extreme emergencies. Fire pails for this use should be galvanized or else painted with asphaltum or tar.

The cost of properly protecting an electric plant from fire will naturally vary widely. Hydraulic plants for long-distance power transmission seldom require the attention in this line which steam plants demand. A few hundred dollars go a long way toward completely protecting all but the largest plants from all fires except those which, humanly speaking, are unpreventable. Safety to life is principally a matter of exits and escapes. The majority of electric-power plants are buildings of one or two stories only, and seldom need extensive external fire escapes. Probably the telephone exchange has the greatest risk to face. Two or three separate exits should always be at hand in these buildings. Every employee should know exactly the resources of his company in the line of fighting fires. Little excuse exists for refusal to spend the small amount of money necessary to secure the greatest safety available in the light of present knowledge.

METAMORPHOSIS OF WIRELESS-TELEGRAPH APPARATUS.

By A. Frederick Collins.

It has always been our assured belief that space telegraphy was destined to supplement, not supplant, the older methods. In this field of new and additional service, however, there has been ample room for growth, and for a development which has transformed almost every feature of the apparatus into something wholly different from that which was found in the first systems. It is the result of this epoch of change that Mr. Collins reviews in the following pages.—The Editors.

DURING the past seven years the means employed for the production, propagation, and reception of electric waves have undergone a change almost as complete as that indicated in the evolution of a caterpillar into a butterfly.

In order to observe the striking advances in the construction of wireless telegraph apparatus it is necessary only to refer to the earlier types of transmitting and receiving instruments, and to compare them with those of more recent origin; by this statement it is not intended to convey the impression that the latest productions are embodied in a specific apparatus, but rather in a theoretic combination representing synthethically the final products of the brains of many workers in space telegraphy.

Again, it must not be inferred that the fundamental principles underlying the art in 1896 have been superseded by other and newer ones; for, on the contrary, the same inherent laws that prevailed then govern the ultimate actions of the electric wave transmission to-day. Hence the necessity for briefly reviewing the original appliances, first for transforming the kinetic energy of electricity into high-potential energy, then converting the static charges into high-frequency, high-voltage currents, the inherent nature of which causes their energy to be damped out, giving rise instead to ether waves in space; and second, the reactionary processes wherein the received wave impulses are by their own imminent quality converted into electric oscillations when, by suitable translating devices, their differentiation is manifested as decipherable signals.

Type of 1896 Transmitter.—The transmitter devised and used by Marconi in his earliest experiments is shown in Figure 1; it comprises

a battery, 1, in series with a modified telegraph key, 2, a mechanical vibrating spring interrupter, 3, and the primary winding, 4, of a Ruhmkorff induction coil; in shunt with the interrupter 3 when it is making contact, and in series with the primary circuit when the interrupter breaks contact, is a condenser, 5; the terminals of the secondary winding, 6, of the induction coil leads to both sides of the oscillator, 7 7′, and from the opposite arms of the latter an aerial wire 8 and a grounded terminal 9 are attached.

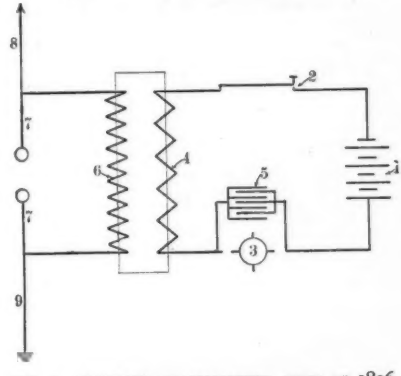
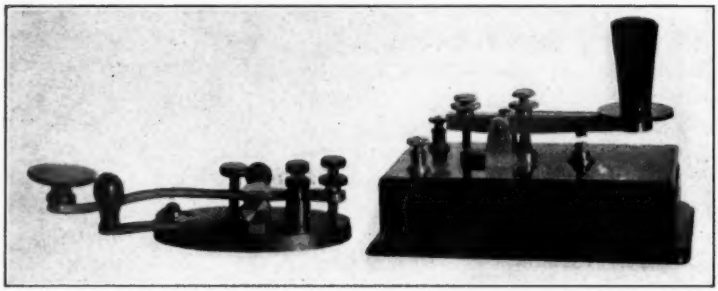


FIG. I. MARCONI TRANSMITTER, TYPE OF 1896.

The function of the different parts of the transmitter in the successive translations of the current when the circuit is closed through the key 2 and the interrupter 4 is as follows:—the current from the battery energizes the primary coil and a magnetic flux is produced, the curved lines of force flowing through the soft-iron core represented by the dotted lines, and these spread out in semi-circles surrounding the coil longitudinally and intersect each convolution; by the well-known laws of induction this induces in one direction a current of high voltage in the secondary coil.

This current gives rise to a static change in the arms of the oscillator, 7 7′, until the potential energy reaches a point at which it will disrupt the air-gap 10, when it is converted into a high-frequency current in the oscillator system. When the primary circuit is broken by the interrupter, a momentary current is induced in the secondary coil in a direction opposite to that of the first induced current, and the inducing primary current flows into the condenser 5; this "make and break" process is repeated automatically until the key 2 is opened, when all operations cease.

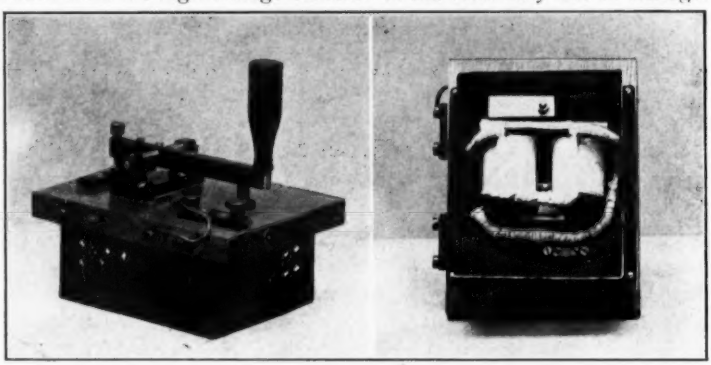
The condenser is shunted around the interrupter, to decrease the sparking of its contacts due to the inductance of the primary current. The capacity of a condenser should have as small a value as will give the maximum length of spark between the terminals of the secondary. This is termed by Johnson its *optimum capacity* and Dr. Ives has proposed a formula for it; it has also been shown by Lord



FIGS. 2 AND 3. ORDINARY TELEGRAPH KEY, AND MARCONI KEY WITH LARGE CONTACTS.

Rayleigh and others that the smaller the time with which the break was made, the smaller the optimum capacity became, so that if an instantaneous break were possible there would be no time for the inductance to rise and the artificial capacity could be eliminated. These and other problems afforded ample opportunity for improvement and this took place along the following lines.

Telegraph Keys.—The making and breaking of the primary current into the alphabetic code of dots and dashes for wireless telegraphy is a matter of importance, and the necessity for modifying and adapting the regular Morse key to this purpose was found desirable very early in wireless-telegraph practice. An ordinary telegraphic key, shown in Figure 2, is of course the most convenient device for manually breaking up the current; but since its carrying capacity is exceedingly limited it is suited only to the working of small coils. Another undesirable feature of this type of key is the constant danger of shock from the high-voltage currents of the secondary due to leakage.



FIGS. 4 AND 5. BRAUN KEY, TOP AND BOTTOM VIEWS.

Marconi designed a simple lever key of large dimensions, amply protected by ebonite insulation and having large brass contacts; the arrangement is illustrated in Figure 3. To cut down the abnormal sparking, condensers have been shunted around the break of the key. In the Slaby-Arco and Braun systems the contacts of the key are provided with electromagnets for blowing out the spark formed on breaking the primary circuit, this arrangement being based on Davy's discovery of the action of a magnetic field upon a voltaic arc, which has in recent years been the subject of much litigation in the United States in the Thompson magnetic blow-out suits. By referring to the photographs Figs. 4 and 5 it will be observed that the magnet is placed in the base of the key where it will not interfere in the manipulation of the lever.

All the above types have a high time constant, owing to their large dimensions, and to overcome this objection both Fessenden and De Forest have chosen a regular Morse key and equipped it with such additional appliances as to meet the requirements of heavy current service and rapid signalling. In the De Forest key, Figure 6, the circuit is broken under oil, and this permits not only of rapid manipulation but also of breaking heavy currents without danger to the apparatus or the operator.

In the Fessenden key a regular Morse key is provided with a vertical rod attached to the end of the lever; to the rod, fingers are fastened so that when the key is depressed these come in contact with wires of a tuning grid and a shunt circuit is formed; by this arrangement the induction coil may be operated continuously and the sending circuit may be thrown in and out of tune in consequence and waves emitted accordingly.

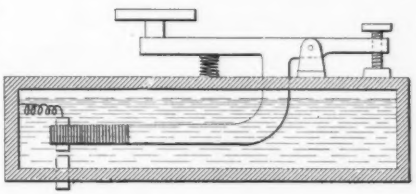


FIG. 6. DE FOREST KEY.

Induction Coils.—Theoretically considered, the induction coil has been carefully and consistently studied since the advent of the wireless telegraph, by such authorities as Lord Rayleigh, Klinglefuss, Walter, Overbeck, Cooley, Jamison, Jaumann, Johnson, and Ives, and many valuable suggestions have been offered for its improvement; but the mechanical construction of the coil has been advanced chiefly on empirical knowledge and the improvements consist in providing better insulation, extending the length of the soft-iron core, and decreasing

the length and increasing the radius of the wire with which the secondary is wound.

In Figure 7 an ordinary induction coil with vibrating interrupter, typical of the pre-wireless-telegraph period, is shown; whilst Figure 8 is a form designed by Fessenden and Figure 9 is the style employed in the Braun-Siemens & Halske transmitter. The two latter induction coils are constructed especially to fulfil the severe requirements demanded by actual service in wireless-telegraph practice.

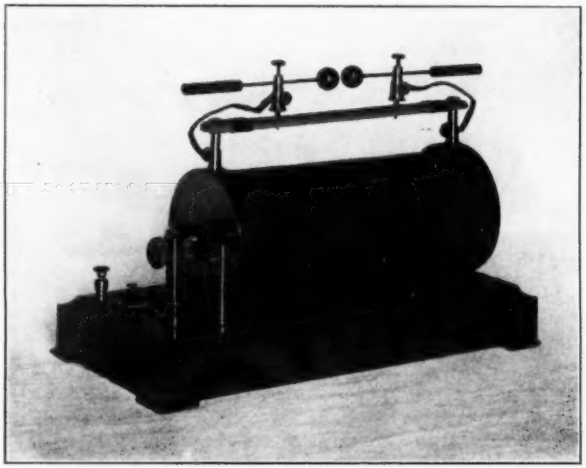


FIG. 7. ORDINARY INDUCTION COIL.

In the Braun-Siemens & Halske coil the diameter of the soft-iron core is large compared with its length, and in the Fessenden coil the core is long compared with the length of the secondary. The best results are obtained when the coil projects about one-fifth of its length beyond the secondary at each end. With a coil of the above dimensions the length of the secondary wire may be minimized, since a greater number of lines of magnetic force will interest each convolution of wire in the secondary at the middle of the primary than at its ends. Then by winding the secondary with wire of comparatively large diameter, increasing its insulation, and carefully treating it to exclude air and moisture, a coil is obtained which possesses remarkable efficiency, eliminates the possibility of electrostatic bombardment which often causes disruption, and minimizes the amount of wire required.

Interrupters.—A simple mechanical vibrating-spring interrupter is shown in Figure 10 and was invented by Wagner and Neff over

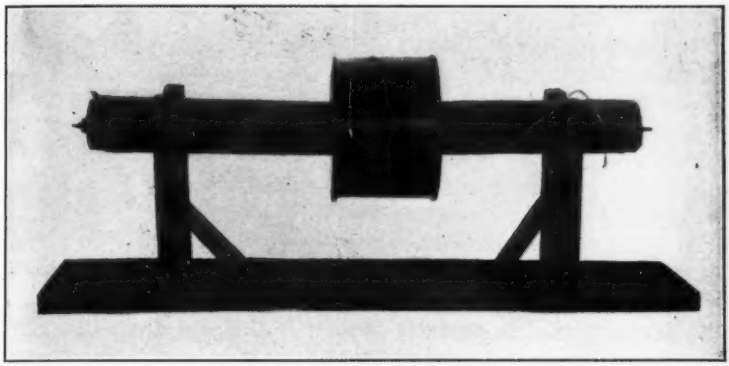


FIG. 8. FESSENDEN INDUCTION COIL WITH LONG INNER COIL.

fifty years ago. This device gives approximately 100 breaks per second. It was the earliest type of interrupter used in connection with an induction coil for wireless telegraphy, and is the simplest and easiest managed type of automatic interrupter made; but its low speed renders it very inefficient, since the radiation of electric waves is proportional to the energy output per unit of time.

To increase the effective radiation the mercury-jet interrupter has been found to give very satisfactory results, and is specified in sev-

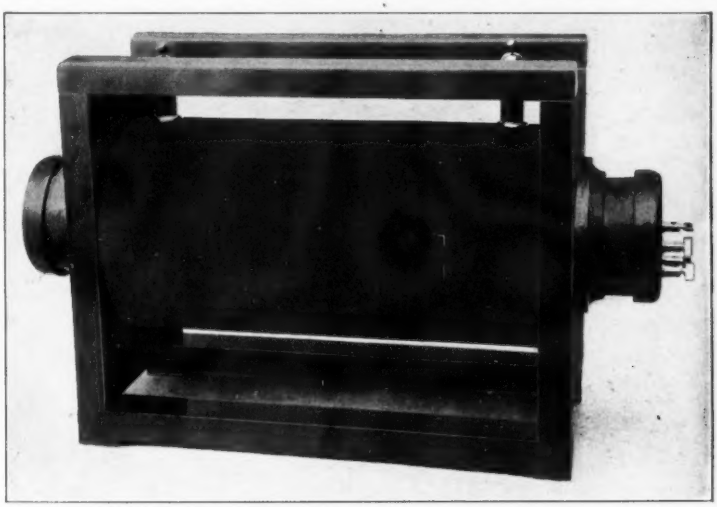


FIG. 9. BRAUN-SIEMENS & HALSKE INDUCTION COIL.

eral of the systems notably the Slaby-Arco. In its usual form, it comprises an enclosed case, having a hollow vertical spindle fitted with an interior screw which when revolved drives the mercury contained at the bottom of the vessel up and out of two oppositely disposed lava-tipped tubes, the centrifugal action projecting the mercury in a steam against two or more sheet-iron sectors; these are connected to the terminals of the induction coil, the circuit being formed through one sector, in at one jet, out of the other jet, and through the second sector.

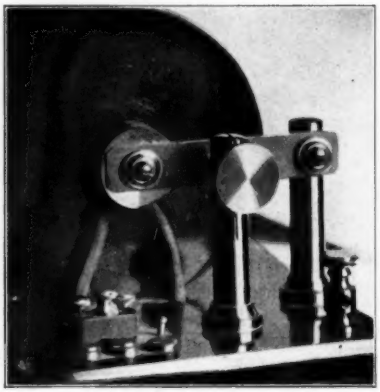


FIG. 10. SIMPLE VIBRATING INTERRUPTER.

After impinging on the sectors the mercury falls back into the vessel to be used over and over again. The break, owing to the great centrifugal velocity of the mercury jet leaving the edge of the sector, is exceedingly sudden. The frequency of the interruptions is variable, and may be 10 or 10,000 per minute, and currents of 25 amperes may be safely carried. While the break is nearly instantaneous it is not ideally so, and therefore a small compensating capacity is required in shunt with it.

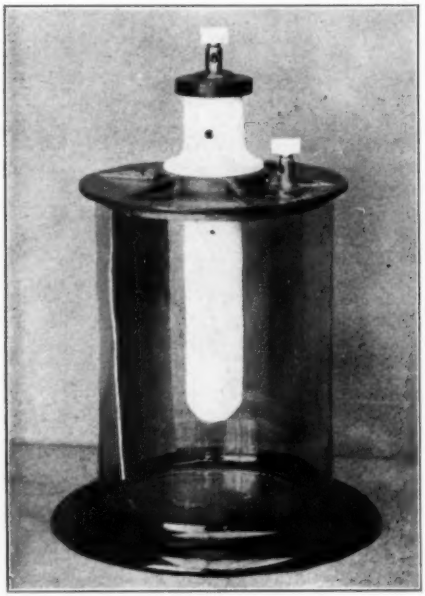


FIG. 11. ELECTROLYTIC INTERRUPTER.

To eliminate the condenser as a factor in making and breaking the circuits, the electrolytic

interrupter has found considerable favor and is included in some of the systems, among them the Braun-Siemens & Halske. The frequency of the breaks ranges from 1,000 to 10,000 per minute. An electrolytic interrupter, Figure 11, consists of a platinum anode having a surface of a few square millimeters, and a lead cathode having a surface of a few hundred square centimeters. Exceedingly sharp breaks take place at the platinum terminal, since minute bubbles of non-conducting gas are instantly and constantly formed, the frequency of which varies directly as the electro-motive force employed and inversely as the area of the platinum exposed. The break is not sharper than in the mercury turbine interrupter, but it possesses an inherent electrolytic capacity sufficient to counteract the inductance of the circuit. The objectionable feature of the mercury interrupter is that deposits occur requiring the frequent cleansing of the apparatus, while in electrolytic interrupters there is always the liability of an explosion due to the electrical ignition of gases formed in the process of electrolysis.

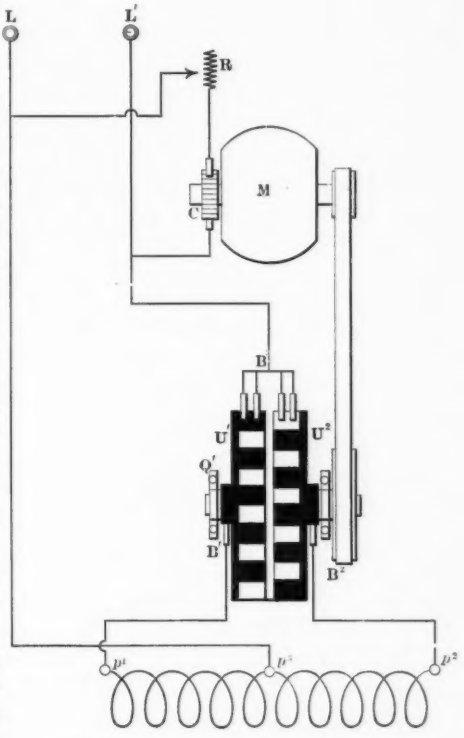


FIG. 12. GRISSON ROTARY INTERRUPTER.

The Grisson continuous alternating-current converter was designed for the transformation of heavy currents mechanically. The device, as its name implies, converts a direct current in the primary coil into an alternating current in the secondary coil. The frequency of alternation ranges from 1,000 to 6,000 per minute and currents of any amperage may be safely used. In the diagram, Figure 12, the scheme will

at once be apparent; p^1 p^2 p^3 represent the primary winding of an induction coil; one of the leading-in wires, L, is connected direct to the middle convolution, p^3; the opposite wire, L^1, leads to a pair of brushes, B^3, where the current is divided on the segmental discs U^1 U^2, which are both fastened on a common shaft but insulated from each other.

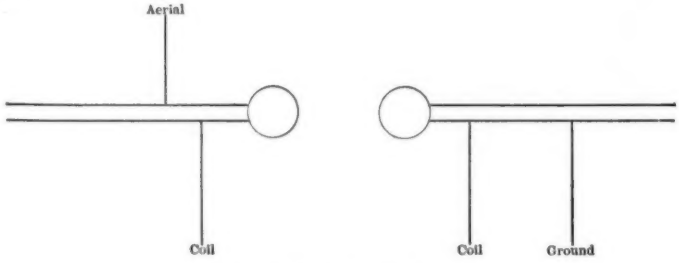


FIG. 13. HERTZ AIR SPARK GAP.

When in operation, continuous currents flow from the wires B^1 B^2 connected to the terminals of the inductor p^1 p^2; this flow continues for the period the brushes B^3 remain in the position shown, when the circuit through the inductor is closed and the maximum value of the current in one direction becomes effectual. As the discs revolve so that the brushes B^3 rest on segments of the commutator, the value of the current will have reached ° and the opposite half of the inductor will be energized and a current in the reverse direction will take place in the secondary winding of the coil. The most objectionable feature found in this converter is the excessive sparking unless the brushes on the segmental disc are adjusted with extreme accuracy.

Spark Gaps.—In Hertz's paper relating to his experiments in electric-wave phenomena, he states that he used an ordinary air spark gap as in Figure 13 for setting up the oscillatory currents, the disruptive discharge taking place between metal spheres connected with the terminals of the secondary coil; and this simple method is largely employed at the present time. The spark gap has however passed through a number of transitions looking toward the fulfilment of more nearly ideal conditions.

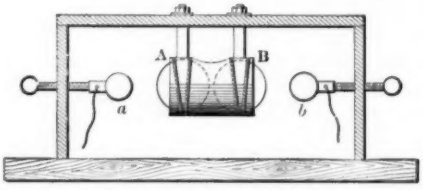


FIG. 14. RIGHI'S OSCILLATOR.

Righi, the preceptor of

Marconi, sought to obtain a more uniform discharge by providing the spark gap with two large brass spheres, A B, Figure 14, separated a distance of a millimeter and having their opposing surfaces arranged in a fluid-tight compartment of hard-rubber containing oil; the outside of each sphere was exposed and receives its charge from the small brass spheres *a b* connected to the secondary of the coils. In Marconi's early apparatus the terminals of A and B were connected to the aerial and earth wires respectively. It was assumed that the inside hemispheres forming the spark gap were kept bright by the oil and that regular and uniform oscillations resulted in consequence. Later these advantages were disclaimed by Marconi, who returned to the simple spark gap of Hertz.

The properties of the disruptive discharge in air under different pressures have been carefully investigated by Fessenden. In his experiments he found that by increasing the pressure of the air its dielectric strength is also increased, and the potential of the oscillator can be enormously increased without decreasing to any appreciable extent the potential of the oscillatory discharge; in this respect it is decidedly more efficient than air under atmospheric pressure, since in the latter case no matter how high the potential is raised no increase in efficiency is obtained after the first inch of spark length is reached. The apparatus for producing the disruptive discharge in compressed air is shown in Figure 15; it consists essentially of an air compressor, 1, and an air chamber, 2; the spark gap is formed between the insulated terminal 3 and the base of the chamber 4; these are attached to the terminals of the secondary and the aerial and earthed wires. By means of this arrangement it is claimed that it

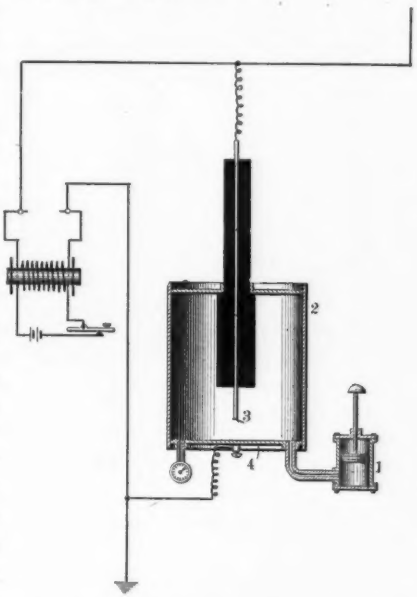


FIG. 15. FESSENDEN'S COMPRESSED AIR SPARK GAP.

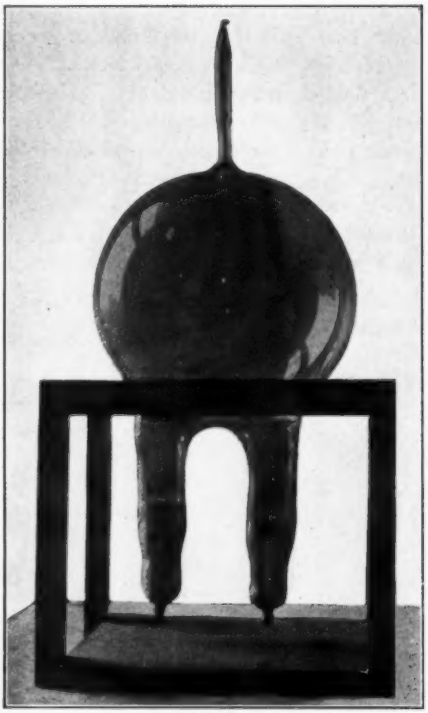


FIG. 16. COOPER HEWITT INTERRUPTER.

is possible to maintain a certain definite relation between the co-efficients of the circuit without regard to the potential employed.

A recent device for regulating the frequency of the spark discharge and converting all the energy into effective radiation is shown in the photograph Figure 16; it is the invention of Cooper Hewitt, and is termed by him an interrupter; but in this case it is interposed between the terminals of the secondary coil instead of the ordinary spark gap. It consists of a modified mercury-vapor lamp in the form of a glass bulb, 8 to 10 inches in diameter and having two sealed tubes in the lower portion containing mercury; leading-in wires form connections with the mercury, and the bulb is then exhausted and hermetically sealed.

The interrupter is connected to the terminals of an induction coil or to condensers in circuit with a secondary of a tranformer operated by an alternating current. When in action the negative electrode offers a resistance to the flow of the current and a potential difference is thus established between the two electrodes until a certain high critical value is reached, when the resistance is broken down; the current then passes without opposition until the difference of potential is nearly equalized, when the initially high resistance again manifests itself instantaneously.

The frequency with which the discharge takes place depends on the inductance and capacity of the circuit and the electromotive force im-

pressed upon it. 2,000 volts will produce an automatically interrupted discharge, while any higher pressure up to 100,000 volts may be employed if desired. As in an ordinary spark gap, the currents set up are oscillatory and the frequency with which the discharges may be effected is limited only by the time required for the charging and discharging of the condensers. By actual tests it has been shown that there is a much greater economy in radiation by means of the mercury interrupter than in ordinary air spark-gaps, since nearly all of the potential energy is converted into kinetic energy in the former.

The last great advance in transforming low-voltage currents into high-voltage alternating currents was made by Fleming, who proposed a method by which the interrupter was entirely eliminated; to effect this, the interruped primary direct current was substituted by a low-voltage alternating current and this was converted into a high-voltage current by means of a commercial alternating-current transformer.

The schematic arrangement is shown in Figure 17. An alternating current generator, 1, is connected with the inductor, 2, of a transformer; the terminals of the secondary winding, 3, are connected in series with a suitable capacity, 4, such as a number of Leyden jars; shunted across this circuit is a spark gap, 5. The operation of this transmitter is exceedingly simple. When alternating currents of low frequency and voltage surge through the primary circuit, which includes the inductor, they induce currents of similar frequency but high voltage in the secondary winding.

Thus a current of 25,000 to 50,000 volts may be had at the terminals of the secondary by utilizing a 500-volt alternating current in the primary. The high-voltage current charges a battery of Leyden jars until the high-potential energy thus stored up finally breaks down the air gap and a disruptive discharge results, converting the static charge into kinetic energy in the form of high-frequency oscillations.

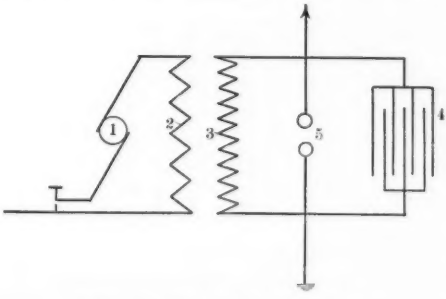


FIG. 17. FLEMING TRANSMITTER.

This is at once the simplest and most efficient transforming apparatus for wireless-telegraph transmitters, and has the advantage over the induction coil in charging both arms of the oscillator system

with equal energy at every reversal, and a current of any amperage may be utilized.

1896 Type of Receiver.—The earliest type of apparatus devised for receiving electric waves and for indicating their presence is illustrated in Figure 18. It consisted of a wave detector in the form of a coherer interposed between the aerial wire and the grounded conductor which formed a resonator system. Since the action of the impressed oscillations on the filings of a coherer is imperceptible to the unaided eye, but is very pronounced in its effect on an electric current, a local circuit is formed which comprises the coherer, *j*, a single dry cell, *g*, and the magnets of a sensitive polarized relay, *n*; a second local circuit includes the contact points of the relay, a battery, *t*, for energizing the tapper magnet, *p*, and for actuating the Morse printing register, *h*. The performance of the various appliances from the action of the electric oscillations on the coherer to the printing of the code on the tape requires some explanation.

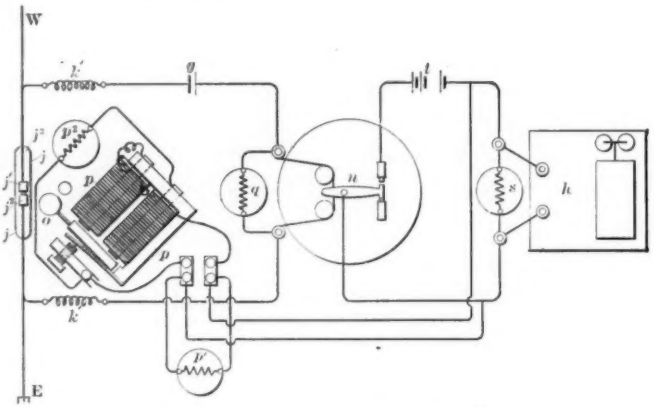
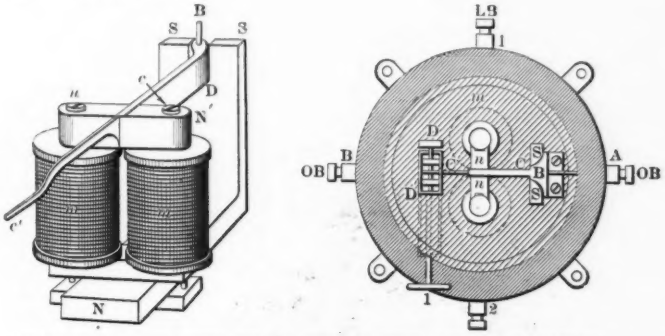


FIG. 18. THE MARCONI RECEIVER OF 1896.

When the oscillatory currents set up by the incoming electric waves meet with the resistance offered by the metal filings of the coherer, the metallic particles are electrically charged to opposite signs, just as are the spheres forming the spark gap of the radiator; but the former being exceedingly small, the air films separating them are correspondingly minute, and when the charges reach a certain maximum critical value the films of air are disrupted and the filings cohere, not merely by mutual attraction (although this is what probably first occurs) but in the last degree they are actually welded together so that where the

normal resistance may have measured thousands of ohms it is lowered to as many tens. Hence, where the current of a local cell could not appreciably manifest itself through the local circuit before the action of the oscillatory current, it now flows feebly through it and energizes the magnet of the relay.

By this action the armature of the relay is attracted and brings into contact a stationary and movable platinum point which closes a second local circuit; this accomplished, a local battery renders the de-coherer operative and causes its tapper to strike the tube and break the filings apart, thereby restoring the coherer to its normally high resistance. Simultaneous with the foregoing the same current actuates the magnets of the register, starting the spring motor and imprinting on a moving tape a dot or a dash.



FIGS. 19, 20. POLARIZED RELAY; GENERAL VIEW AND TOP ELEVATION.

The capricious action of the coherer, together with the element of time required for the consummation of the preceding processes and the necessity for constant adjustment of the instruments, indicated plainly that improvements were in order.

Relays.—The ordinary line relay was used in the earliest experimental receptors. In its usual form, as is well known, an electromagnet is secured to a frame in a horizontal position; its armature is delicately pivoted and is provided with contact points, and the movements of the former open and close the local circuit containing the tapper and register. This type of relay is usually wound to 150 ohms and does not possess nearly the sensitivity demanded in the practice of wireless telegraphy.

Recourse was had to the polarized relay, an instrument of extreme sensitiveness considering the mass of metal it controls; the ordinary type consists of an electromagnet *m m* Figure 19, with soft-iron cores

resting on the positive pole of a permanent magnet; when no current is flowing through the coils of the magnet both polar projections *n n* are positively magnetized, but when a current, however feeble, flows through the coils, one of the poles of the electromagnet becomes more strongly positive, while the opposite changes its polarity to negative.

This causes the armature lever to be attracted and repelled without the aid of a retractile spring. This lever c c^1 is of soft iron and is pivoted at B on the negative pole s s of the permanent magnet; it is constructed so that it will just clear the polar projections *n n;* the end of the lever *c* when no current is flowing rests against an insulated stationary contact, D, Figure 20; but when the current passes the lever is drawn into contact with D^1, closing the second local circuit in which the decoherer and register is placed. Figure 21 is a photograph of the polarized relay used in the Marconi system. Since it is balanced by magnetic action and its coils are often wound to a resistance of 10,000 ohms, a very feeble current may be utilized for throwing into circuit heavy currents. The polarized relay is employed as an intermediate appliance between voltage-operated wave detectors and the indicating

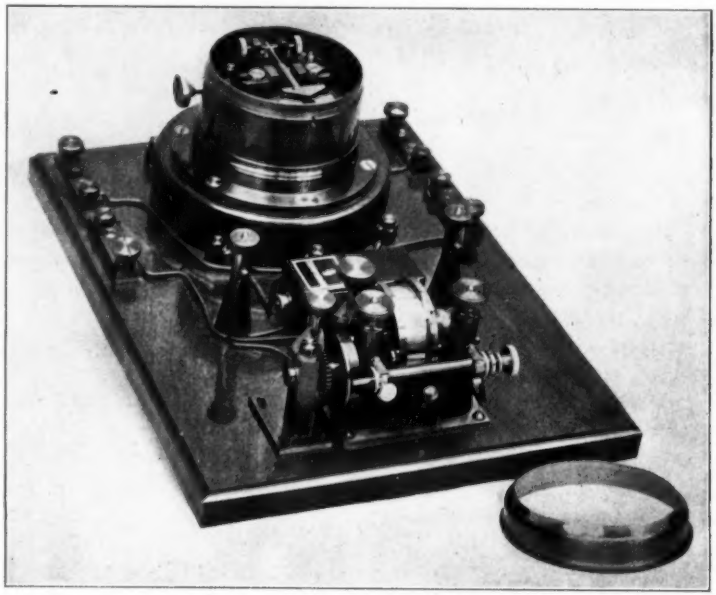


FIG. 21. POLARIZED RELAY (IN THE BACKGROUND), AND FIG. 23. BRAUN-SIEMENS & HALSKE TAPPER.

mechanism except in the Lodge-Muirhead system, wherein a coherer and a siphon recorder are direct-connected.

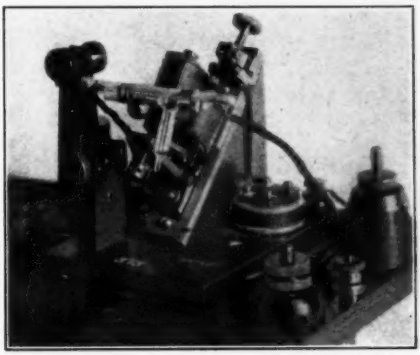


FIG. 22. THE MARCONI TAPPER.

Decoherers.—In the matter of decoherers there has been little need for improvement, the earliest contrivances serving fairly well the purpose for which they were constructed. In Figure 22 a Marconi tapper is shown. It consists essentially of an electromagnet having an automatic contact breaker similar to an electric bell. The armature lever is permanently attached to the frame by means of a straight, stiff, steel spring, the elasticity of which draws the armature away from the poles of the magnet and into contact with a platinum point connected in series with the magnet armature and source of current.

The striking hammer is placed very close to the armature so that its period of vibration may be quickened, for its time constant when compared with the movement of the printing lever of the register must be low; the ratio should be as five is to one—so that the former should vibrate at least five times to every stroke of the lever of the register; it is this ratio of adjustment that permits a series of wave impulses to be registered in a continuous line representing a dash. Screws for moving the magnets and for obtaining the proper relation between the coherer and magnets are provided.

By referring to Figure 24 representing Guarini's decoherer the arrangement will be more clearly depicted. The spiral spring and screw gives a micrometer adjustment permitting strokes of any degree of delicacy to impinge upon the coherer. In the Braun-Siemens & Halske receptor an electromechanical decoherer is employed in contradistinction to those described which are purely electrical in operation. In this device the lever of the tapper is operated mechanically by a spring motor, the latter being actuated by a local current. It is evident that in electrically operated tappers the strength of the strokes varies proportionally to the strength of the current. In mechanically operated decoherers the blows are delivered with exactly the same force regardless of the current. The arrangement is illustrated in Figure 23.

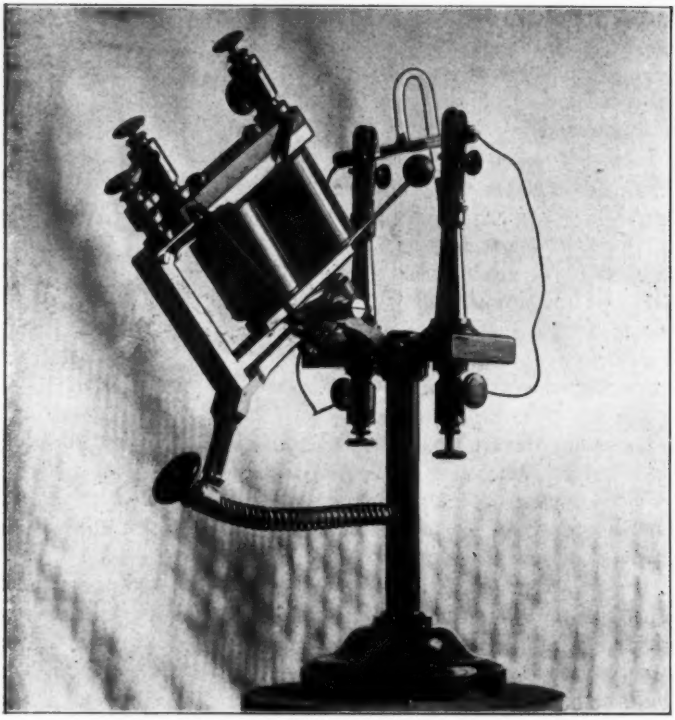


FIG. 24. GUARINI TAPPER AND BLONDEL'S REGENERABLE COHERER.

Electric-Wave Detectors.—There has been more time and energy expended by inventors in the improvement of electric-wave detectors than in any other one part of the receiving apparatus. Branly's discovery of the action of electric waves on metal filings belonged to the pre-wireless period; his radio-conductor, diagrammatically represented in Figure 25 was however the prototype of the modern coherer. It will be observed that A B and C D are conductor plugs, the cavity of the ebonite cup containing the metal filings; when sparks passed between the knobs of a frictional machine, though the detector was 10 meters distant, the resistance of the filings was decreased by hundreds of ohms.

Lodge modified this detector and gave it the name of coherer. With it he experimentally showed the possibility of using a Hertz transmitter for sending messages wirelessly. His coherer, Figure 26, consisted of a glass tube having a bore of 1 centimeter and a length of 18

centimeters; the ends were provided with conductor plugs so that the pressure upon the filings could be adjusted by means of a screw. The resistance of the filings was enormous in virtue of the great cross section and length of the tube.

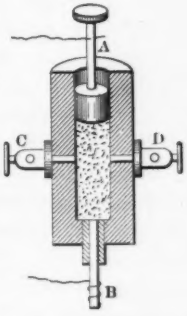


FIG. 25. BRANLEY'S RADIO-COHERER.

The coherer designed by Marconi for his early experiments was a gigantic stride toward the goal of commercial wireless telegraphy. His coherer is shown full size in Figure 27, and the metamorphosis of the Lodge coherer into the one under consideration was the result of three improvements, namely:—decreasing the size of the tube and the amount of the filings, substituting nickel and silver filings for brass or aluminum, and exhausting the tube of its air. In these details, together with extreme care taken in the construction of the tubes, lies the chief secret of Marconi's success.

The conductor plugs are of silver and are made to conform to the inside diameter of the tube; in the pocket thus formed a mixture of 90 per cent. of silver and 10 per cent. of nickel is placed, and the tube tested for sensitiveness, after which the wire terminals leading from the conductor plugs are sealed in, and finally the tube is exhausted by means of a mercury air pump and the nipple sealed off when the coherer is ready for use.

Very early in the history of wireless telegraphy it was pointed out that carbon and some other substances were self-restoring—that is, the effect of the oscillations in lowering the resistance offered by them was momentary and the instant the oscillations ceased the granules by an inherent property instantly decohered. While carbon does not require a tapper to restore it to its normal resistivity, the range of variability between maximum conductivity and maximum resistivity is so exceedingly small that the most sensitive relay is not affected by it. Therefore a telephone receiver is used in connection with it.

The speed with which auto-coherers operate was an advantage of

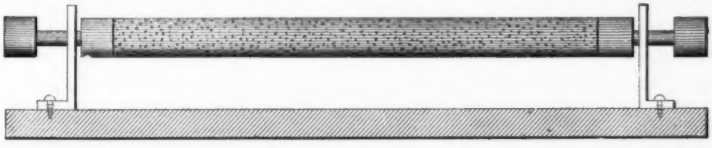


FIG. 26. LODGE'S FIRST COHERER. ABOUT ½ SIZE.

great importance and their characteristic principles have been utilized in different systems.

One of the most sensitive detectors of electric waves is due to Dr. Lee de Forest, who made exhaustive tests with self-restoring devices and finally discovered that a mixture of oxide of lead and glycerine would respond to the feeblest oscillations. Its action is due to electrolysis and the diagram A Figure 28 gives a graphic representation of how metallic threads are built up through the mixture by the local direct current between the conducting plugs forming the anode and cathode, while B indicates how these threads are disrupted by the oscillations. Hence the responder is an anti-coherer, *i. e.*, its normal resistance is low but is greatly increased when the oscillations effect disruption.

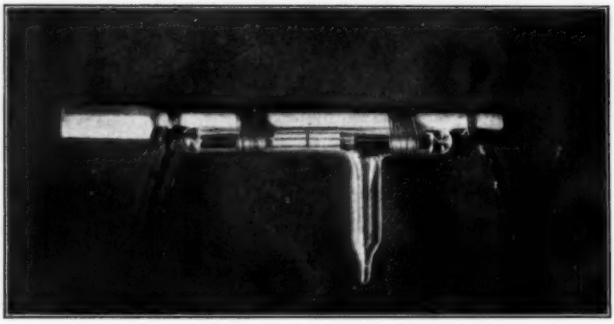


FIG. 27. MARCONI COHERER.

It will be remembered that the press a year ago gave a great deal of space to the Solari coherer, which device, it was alleged, Marconi had appropriated for his own use in his Transatlantic tests. Lieut. Solari was the first to point out the exceeding sensitiveness of a globule of mercury when interposed between two iron conductor plugs as indicated in the diagram Figure 29; like the auto-coherers previously described its use is limited to a telephone receiver.

Lodge has devised a new and ingenious coherer which may not properly be termed self-restoring, yet its restorative properties are at every instant present. It comprises a small steel disk revolved by a spring motor and having its peripheral edge in constant contact with a column of mercury. In the diagram, Figure 30, *a* is the steel disc, *b* the mercury, *c* a platinum spiral making contact with the mercury, and *d* a containing vessel. It is also photographically depicted in Figure 31.

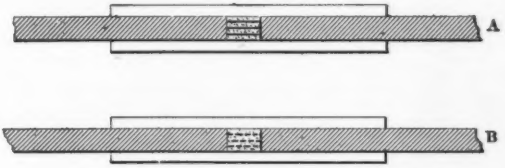


FIG. 28. DE FOREST ELECTROLYTIC RESPONDER.

It is obvious that the instant the oscillations cohere the particles of the mercury and steel the disc traverses a certain small arc of its revolution and the cohered molecules are broken asunder and a fresh surface is again exposed. It is a coherer of great sensitiveness and has a range of resistance variability wide enough to permit a siphon recorder to be actuated directly by it without the intervention of a relay.

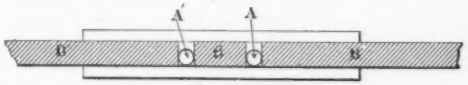


FIG. 29. SOLARI COHERER.
A, A', globules of mercury; B, B', iron plugs.

Marconi Magnetic Wave Detector.—The magnetic detector is based on the observations of Henry, Rutherford and others and involves the action of electric oscillations on magnetic bodies; the detector of Marconi combines with this phenomenon the principle of magnetic hysteresis. It comprises a glass tube of small diameter on which is wound a single layer of fine insulated wire, the terminals leading to aerial wire and earth respectively. A second coil of wire is slipped over the first coil and is connected in series with a telephone receiver; two grooved wheels are connected with a flexible band of iron wire and caused to traverse its course through the glass tube and small transformer by means of a spring motor.

Two steel horseshoe magnets are placed close to the coils; when oscillations are set up in the primary coil the magnetic intensity of the moving band of iron wire is changed and induced currents surge in the secondary coil and are indicated in the telephone receiver.

The word *sensitiveness* as applied to the foregoing detectors is used in an arbitrary sense, but according to measurements made

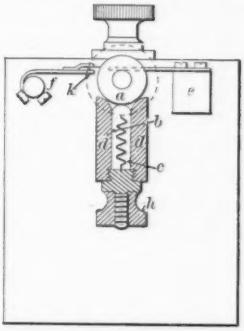


FIG. 30. LODGE COHERER.

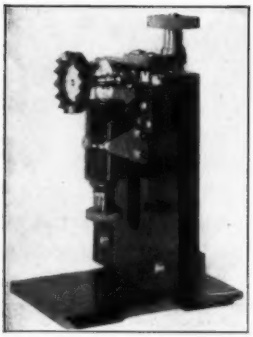


FIG. 31. LODGE ROTATING MERCURIAL COHERER.

by Fessenden it requires from one to four ergs to produce an indication with any of the above coherers, since they owe their changes in resistance to the *voltage* of the oscillations. Fessenden determined that a *current-operated* detector would offer advantages over those operated by voltage and based these deductions on his hot-wire barreter.* In his new liquid barreter, shown in the diagram, Figure 32, a small column of nitric acid with a minute platinum wire is used in place of the loop of fine wire formerly employed. Its principal advantage over voltage-operated coherers is its cumulative action, by means of which the entire energy received is utilized in producing indications.

By its use the sharpest tuning may be accomplished, and where coherers give resonant rises of less than 10 per cent. a barreter will give a resonant rise of at least 400 per cent. Once made it is always in adjustment; and again, it is not affected by atmospheric disturbances and it need not be enclosed in a grounded metallic box since a spark from an induction coil in the immediate vicinity of it will not affect it in the slightest degree. Last, but not least, its range of resistivity is sufficient to permit the use of a siphon recorder.

Indicators.—In the beginning of wireless telegraphy it was apparent that while the factor of time was practically negligible so far as the transmission of electric waves was concerned, yet this constant assumed a very high value in the actuation and operation of the apparatus. This is especially true of the receiver, as the various electro-mechanical apparatus require a specific time for the performance of their functions, limiting the number of words which may be successfully transmitted to twelve or fifteen per minute. It is difficult for an operator to read by sound the Morse characters where they are so slowly translated; again, atmospheric and other disturbance, produce "X's" or

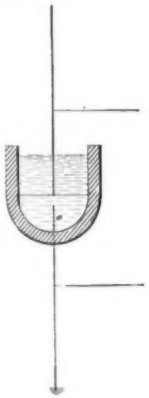
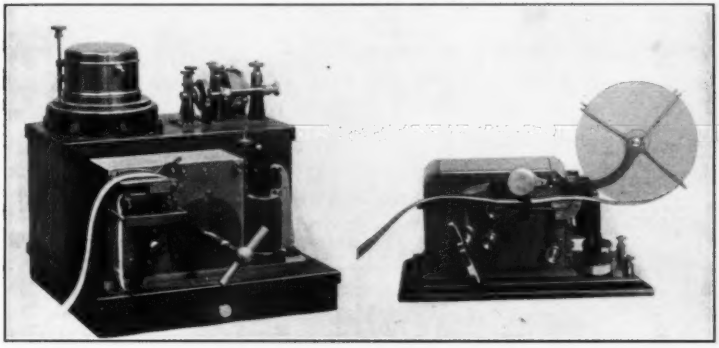


FIG. 32. FESSENDEN NEW BARRETER.

* Since the publication of my paper in THE ENGINEERING MAGAZINE, November, 1903, in which Fessenden's hot-wire barreter was described, he has invented the liquid barreter now described.

"strays," and these are confusing to the sense of hearing when recorded audibly; finally, it is often convenient to have a printed record.

These considerations lead to the adoption of the Morse printing register. The type used in wireless-telegraph receptors is in all respects similar to that employed in ordinary telegraphy, except that the armature lever to which the paper-guide is attached has a higher time constant. This permits successive dots, due to the breaking up of the local current by the action of the tapper on the coherer, to run together thus form the dashes of the code.



FIGS. 33 AND 33B. ON THE LEFT IS THE POLARIZED RELAY AND MORSE RECORDER OF THE BRAUN-SIEMENS & HALSKE RECEIVING SYSTEM. ON THE RIGHT IS A MORSE REGISTER OF THE AMERICAN TYPE.

The register consists essentially of a dust-proof brass case, with glass top, containing a spring motor and operating mechanism for drawing a paper tape at a pre-determined rate of speed under an inked printing disk revolving on a stationary pin. An electromagnet at the rear of the case is connected with the relay of the receptor and when energized by a local current, its armature is attracted, setting the motor mechanism into action and also causing the tape to be drawn into contact with the printing disc, thereby registering a dot or dash as the case may be. The usual form of register is shown in Figure 33. In the Slaby-Arco and Braun-Siemens & Halske receptors it is self-starting and self-stopping; in the Marconi apparatus it is started by hand.

The siphon recorder, Figure 34, is at present finding favor among wireless-telegraph engineers as a means of indicating messages, since by its use auto-wave-detectors, having a limited range of variability, may be employed without the intervention of a relay and at the same time a permanent record may be obtained.

In the siphon recorder a paper tape is set in motion as in the pre-

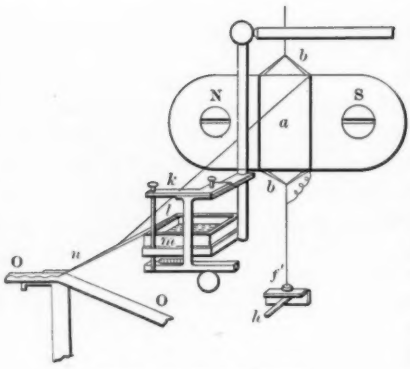


FIG. 34. SIPHON RECORDER.

viously described recorder. A fine glass siphon, receiving its supply of ink from a vessel, is suspended by a fine wire and is moved by a coil of fine wire suspended by a fiber between the poles of a powerful compound permanent magnet as in a reflecting galvanometer. The coil has a stationary magnetic soft-iron core which is magnetized by induction and strengthens the magnetic field of the permanent magnet.

The local current passes through the wave-detector and the suspended coil of wire when it swings in either direction according to the strength of the current impressed upon it; this moves the siphon, the upward strokes recording dots and the downward movements dashes.

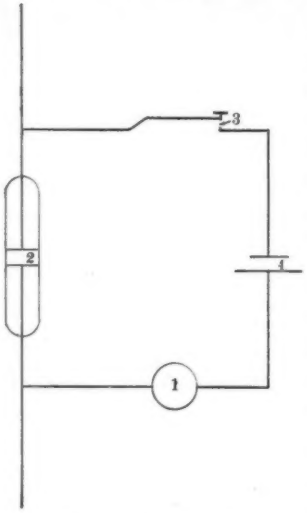


FIG. 35. METAMORPHOSED WIRELESS-TELEGRAPH RECEPTOR.

The telephone receiver, owing to its extraordinary sensitiveness, has been adopted by de Forest and Fessenden in their regular wireless receptors and by Braun-Siemens & Halske and Slaby-Arco in their field equipments. Owing to its simplicity, permanency of adjustment, and speed of operation, it is especially applicable to wireless-telegraph work in connection with auto-detectors. The code is read by the sharp clicks of the diaphragm; as in the ordinary telegraph sounder, it has two characteristic sounds, the first when the current is made and the second when the circuit is broken. With a telephone receiver 1, and an auto-coherer 2 connected as shown in Figure 35 the metamorphosis of the wireless-telegraph receptor is complete, and a simple, sure, and speedy instrument is the final result.

A STREET IN POCAHONTAS.

SOCIAL AND INDUSTRIAL CONDITIONS IN THE POCAHONTAS COAL FIELDS.

By Geo. L. Fowler.

In a preceding paper Mr. Fowler reviewed the physical and mechanical features of the Pocahontas mines. The present article rakes up the economic aspects of the industry—especially the condition and earnings of the miners. These are particularly interesting because in coal mining the wage of the employee is a more than usually direct function of the market price of the product.—THE EDITORS.

IN reviewing the Pocahontas coal region, as with any other great industry, it would be possible to prove almost any case, even the most extreme, by taking isolated examples and treating them as typical of the whole, a course that I shall attempt most carefully to avoid. The conditions presented by this industry are peculiar in one respect at least, in that it contains an element widely considered a problem of national importance, though those brought most intimately into contact with it regard the matter as local and beyond the province of interference by outsiders. This is the so-called negro question. If, therefore, it is given a position of some prominence in the discussion, it is because it is of the greatest importance to the region and is closely associated not only with the history of its past development, but with such growth as may be brought about in the future.

A COKE DRAWER.

Beyond this great question there are the minor ones of the physical conditions surrounding the home life of the people, the wages it is possible to earn, the regard for law and order prevalent in the community, the influence of the companies upon the life of the people, the character of the laborer, and the cost of living. No attempt will be made to treat these items under separate headings, as they are too intimately interwoven to admit of complete separation, but the subject will be handled in a way to bring them each and all into the light.

Here, as elsewhere throughout the south, the negro is the predominating figure, and we find him employed in all grades of labor where cool judgment, high personal responsibility, or reliability are not required. There is a wonderful degree of unanimity amongst all classes of employers as to his character, and this extends to all, whether they originally come from the north or the south. In the Pocahontas fields the managers and owners are nearly all from the north, many coming from Pennsylvania and Ohio, and there could hardly be one word of dispute between them and the greatest Southerner of them all in regard to the worth of the negro. First of all, they reiterate Miss Ophelia's opinion of his shiftlessness, adding thereto the belief that he belongs to an inferior race—that he ordinarily matures in early manhood and does not grow after that time. In short, that he is a child in his actions and ways of thinking, and is an adult in physical strength only. At the same time he is keenly alive to his rights, and promptly quits work the moment he feels that he is being imposed upon.

This condition of undeveloped mentality or childishness displays itself especially in the uneasy desire to be on the move and to seek for a different environment, though it may be but temporary. It is especially displayed by the desire to ride on the cars, and though there is no reason on earth for it, he is everlastingly on the move. This is most curiously exemplified by the fact that the one place in the region where it is possible and easy to hold the negro laborer, is the work train. He will stick to this with a persistency that is truly admirable, apparently for the reason that the periods of hard labor are interrupted at frequent intervals by rides on the cars. If, in addition to this, the railroad company will run a train or car to take him to town on Saturday night, the labor problem, as far as the work train is concerned, is solved.

Pay day invariably sees an exodus, and so long as there is any money in the pocket and the stomach is full it is very difficult to allure or force him back to his work. As his standard of living is very low, and as wages are comparatively high, three days in the week is quite sufficient to enable most of his class to live, and this is about all that they care to work, though perhaps below the average. The result is that all through the coal fields many more men are kept upon the pay rolls than are required to do the work, because of the constant defections that occur as the result of a full stomach and pay day.

Closely associated with the shiftlessness, and indeed a part of it, is the apparent inability of the negro to bear any burden of responsibility. This is recognized everywhere, with the result that negroes are not trusted in positions where judgment is required. As one example of the small details into which this extends, it is desired to keep a record of the charging of each individual coke oven. As the charging lorrey starts down the line it is weighed, and on its return the driver is expected to give to the weighmaster the number of the oven into which it was dumped. It has been found to be al-

WHITE MINERS' CHILDREN, POCAHONTAS.

most impossible to get the ordinary negro to give the correct number. He will say anything that comes into his head, and his inaccuracies render the record useless, simply because of his failure to remember the number that has been given him. This unreliability manifests itself in every way, and among the most annoying is in the use of kerosene in the open miner's lamp.

As the safety lamp is not needed in the Pocahontas mines, the open flame is used. The law, however, does require that miners' oil (a mixture of cotton-seed and lard oil) be used. It is almost impossible to prevent the men from adulterating this with kerosene, on account of the saving in cost, much to the detriment of the ventilation and to the increase of the danger of the work. In fact, it is the universal testimony of employers in all sections of the country, that the most persistent and flagrant violators of the laws enacted for their comfort and protection are the miners themselves.

For these reasons the negro is not placed in such positions of responsibility as locomotive-engine driving and the like.

The rivals of the negro in this field of labor are the Hungarians and Italians. They differ from him not in a higher standard of living, but in the thriftiness of saving. There is a constant flow of money orders from points where they are employed to Hungarian and Italian bankers in New York, as well as to friends and relatives abroad. This thriftiness extends to their work, and they are not only willing and anxious to work every day in the week, but discontent soon shows itself if they are unable to do so. One operator informed me that he thought the average Italian would save 80 per cent. of his earnings, and the postmaster at Gary told me that in the first three days after the establishment of a money-order office at that place, he issued five hundred orders drawn on New York and abroad, and that for weeks he was out of blanks most of the time because they could not be obtained as rapidly as they were called for.

As yet the Italians are not employed as miners, but there are numbers of Hungarians so engaged who have been brought down from Pennsylvania. The proportion of white miners to the whole is about 15 per cent. Hungarians, and an equal number of natives from West Virginia, Virginia, and North Carolina.

The last class belonging in the field of labor in the region are the natives. They are so few, however, as to exert no appreciable influence in one way or another. They make good woodsmen and guides, but their shiftless methods of living have not accustomed them to continuous and sustained labor and very little suffices. In short, they

resemble the negro in their desire for frequent periods or "laying off." They are better than the mountain whites, who are forlorn and miserable in appearance and behavior; but, never having known or dreamed of anything better than the wretched surroundings of their everyday life, they are supremely unconscious of their own misery. How these mountaineers live or eke out an existence on their wretched farms is a mystery difficult to understand, while their lives of isolation among the steep gullies must partake strongly of the nature of utter desolation, since the country is undeveloped in the extreme, the roads are little better than bridle paths, and all intercommunication, save on the railroad, is by foot or horseback.

A CHARACTERISTIC GROUP OF MINERS IN THE POCAHONTAS FIELD.

With a community made up of such characters, and a population that might almost be called floating, it has been impossible, thus far, for the labor organizations to obtain a foothold. To be sure, there have been very strenuous exertions on the part of the owners to keep them out, and up to the present they have been successful; it is probable they will continue to be so, for many of the miners living in the field are at all times in close contact with their employers, so that when labor organizers make their appearance, and attempt to turn employees against their employers by making false statements, they are rarely successful, for the reason that the former's long knowledge of the latter enables him to detect the falsity at once. Then there is the fur-

A STREET IN GARY—A VIRGINIA COAL-MINING TOWN.

ther bar that in other States the unions will not permit the negro to join. As he is thoroughly well acquainted with this fact and with the conditions existing in Ohio, Indiana, and Illinois, he has no inclination, but rather an aversion, to joining a union.

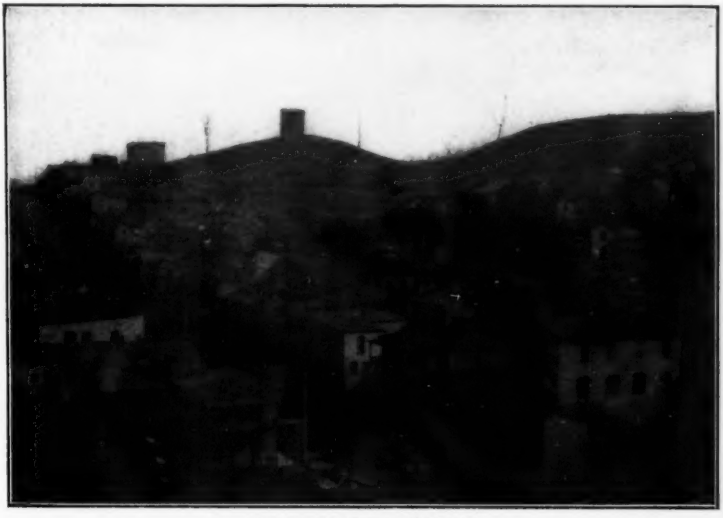
As to the educational standard of the community as a whole, it would be regarded as low from the viewpoint of the more densely settled communities of the north. Graded schools are rare and will probably continue to be so, as the sparsity of population, except at a few points, will not permit of their existence. In some places the companies have provided good schools, and the period of school term has been increased from four months, as it was in the early days of the field, to nine months a year. As would naturally be supposed, the general sentiment of the people is not clamorous for educational advantages; and this, coupled with their low mental calibre, serves as a check to any marked elevation of public intelligence, though absolute illiteracy is almost unknown and there are exceptional cases of a high degree of mental brightness.

With such elements forming the basis of society and having a mere sprinkling of managers, clerks, and foremen to form only an insignificant minority, the standard of the community in some respects is decidedly low and the respect for law and order seems, at times, almost

to disappear—though probably it is no worse than among the same classes in the cities. Here, however, nothing is hidden. Everything is done openly; and yet, on the whole, the villages that cluster about the mines are as quiet and orderly as one in New England, and a stranger as free from molestation. But among the negroes there is a suspicion of one another and a quarrelsomeness when slightly under the influence of liquor that renders them decidedly dangerous. A large majority of them go armed with revolvers, and their appreciation of a good weapon is such that the best is none too good; $16 and $20 are commonly paid for them, while the swell occasionally carries a fancy gold-mounted affair costing much more.

The danger to the white in such a community lies in accidentally crossing the path of a semi-intoxicated negro, whom liquor makes surly and quarrelsome and imbues with a false courage and a desire to display it. Such a man is to be avoided, as the chances are that he is armed and will not hesitate to use his revolver if he is provoked.

The other precaution to be taken is to keep away from their quarrels. These usually arise over a game of craps or cards or some trivial dispute, resulting in a shooting that frequently ends in the death of one or both parties to the affair. When such an event does take place, the onlookers scurry away like rats into their holes and the victim is left where he has fallen, until he is found by the whites or the



THE TOWN OF POCAHONTAS.

authorities. Formerly nothing would have been said about such a case, and an investigation would have been almost hopeless on account of the difficulty of locating the spectators. In fact, a few years ago such an affair would have been regarded as too insignificant to be reported and the victim would have been buried as a fitting end to the matter; but, now, an attempt is invariably made to arrest the criminal, though this is frequently of the greatest difficulty on account of the nearness of the State line and the possibility of escaping into the mountains where it is exceedingly difficult to follow. And yet, despite such a state of affairs, the stranger or the white has nothing to fear so long as he does not interfere in their quarrels or subject himself to a possible hold-up by straying into low haunts at night. There is no trouble in the community from robberies, burglaries, or hold-ups, and this class of crime is practically unknown. In short, it may be summed up as an exceedingly rough but by no means dangerous community.

Of course the sustaining element of the whole region is the coal

A MINER'S HOUSE, SWITCHBACK, WEST VIRGINIA.

company, and it is too frequently held responsible for everything that is bad, while the leaven of good that is to be found is accredited to the efforts of the miners to better their condition. It is, perhaps, possible that greater exertion on the part of the controlling companies might ameliorate the existing conditions to a certain extent, but where such

attempts have been made the discouragement has been very, very great, as will be shown later; and one who has been upon the ground is apt to reverse the usual judgment and attribute what of good there is to the companies and consider the evils to exist in spite of their best endeavors to prevent them.

A HOUSE FOR SINGLE MEN, AT ENNIS, IN THE WEST VIRGINIA COAL-MINING REGION.

At all times the companies make every effort to better the condition of their employees. At nearly every operation, there will be found one or more churches, to which help has always been given, both for the erection of the buildings and the support of the pastors.

Ordinarily the standard of living of a community is dependent upon the wage-earning capacity of the inhabitants. As this rises so do the morals of the people, but this seems to have had but little effect in the Pocahontas country. Under the ordinary normal conditions of business the wages it is possible to earn are higher than in many more highly developed places. The miner is paid by the car load, at the rate of about 85 cents for room work and 90 cents for entry work, and on this, if working steadily with eight-hour shifts, he can make more than $100 a month. The coke drawers receive 60 to 65 cents an oven and can pull three or four in seven hours, while the day laborer is paid $1.50 a day, and these are fair samples of the other grades. But, ow-

A MINE STORE IN THE POCAHONTAS REGION.

ing to the peculiar characteristics that have been detailed, these wages are not earned continuously. The miner runs from $60 to $70 a month; the coke drawer works three or four days in the week, and the rest in the same proportion; so that the actual wages received are low—much lower than they need be, and away below what the owners would like to see the individual earn.

Wages mean but little, however, unless the cost of living is taken into consideration, and with this comes in that familiar topic of the company store. To call it an unmitigated evil, as has been so frequently done, is absurd. To say that it is altogether good and above reproach would be something of a strain upon the truth; but to say that it is an absolute necessity, under existing conditions, is well within the mark. The character of the workman is such that he lives well up to the last cent of his earnings, and must needs ask for advances. His total disregard of all personal obligations would render it impossible for an outsider to do a credit business with him. This can only be done, therefore, by the employer, who knows at all times what is his due, and can limit or extend the credit advances accordingly.

The major portion of the wages are paid in company scrip in advance of pay day, and while the details of the method vary, the following example may be taken as fairly typical of the method in general use. On the first of the month the employee receives a card like the following, which is known as a stoppage card:—

The name and number of the employee and the month of issue are written at the top, and as scrip is issued from time to time on the presentation of the card, the amount is written in after the date of issue, so that both parties have a record of the amount at all times. The scrip is in denominations of $1.00, $2.00, $3.00, $4.00, $5.00, $6.00, $8.00 and $10.00 and is of the form shown on the following page.

The stub is retained by the cashier, and as the scrip is presented at the store the prices of the articles purchased in cents will be punched out on the margin until it is exhausted. These figures in the case illustrated will be found to foot up to $3.00. This scrip is sometimes issued in excess of the earnings of the employee, but usually it is limited to the amount of his credits. The method is very simple; the card is presented at the cashier's window and the amount desired named. This is issued and purchases made.

Moonlight Coal and Coke Company

STOPPAGES

AGAINST ACCOUNT OF

Mr. _____

No. _____ _____ *190*

1				17		
2				18		
3				19		
4				20		
5				21		
6				22		
7				23		
8				24		
9				25		
10				26		
11				27		
12				28		
13				29		
14				30		
15				31		
16						
				TOTAL,		

This ticket must be sent or brought to the office when advances are wished.

If Lost No Duplicate will be Issued.

STOPPAGE CARD.

$3.00 No. 500

Tip Top, W. Va., ... 190

ORDER OF

BY

No. 500 Tip Top, W. Va., ... 190

MOONLIGHT COAL & COKE CO.

Charge to my account $3.00, and give bearer Merchandise to the amount of same, at such time, or times, as this order is presented at the counters of your store room, until all the amounts on margin thereof are punched out.

Always bring this order with you

Signed .....

Witness .....

50 50 25 25 20 20 20 20 10 10

COMPANY SCRIP.

So far there can be no objection to the method, but objectors find fault with the alleged compulsion upon the employee to trade at the company store, and that, too, at exorbitant prices. This is but partly true. That the employee at isolated mines is at times compelled to trade at the company store is true, as there is no other, for the very good reason already given. That the prices are exorbitant is not true, except in occasional instances. These depend upon the company. The large corporations do not run the mines for the benefit of the store. The latter is compelled to stand upon its own merits and to be able to meet any competition. There is no pretense that it is run as a partial charity, but no attempt is made to overcharge, and there is never the slightest effort to compel the employee to deal at the company store rather than elsewhere. The main inducement is that the prices at such stores are usually below those charged for the same grade of goods by outsiders—a condition rendered possible by the fact that purchases are made to the best possible advantage in large quantities, and only a fair profit added. In the case of some of the smaller companies, however, the prices are high, higher than the situation warrants; but the employee is rarely helpless in the matter; for, when such a condition exists, wagons from adjoining towns can be seen delivering goods from individual stores on their daily rounds. The main foothold, however, of the outside stores lies in the fact that such stores handle only an inferior class of goods, which being sold at a lower price, lead the workman to believe that there is an overcharge for those handled by the company.

In reviewing these conditions it is unfair to compare absolutely with those in more favored regions. It must be remembered that the field is isolated from the rest of the country, is a long distance from markets, that the freight charges are high, and that the country itself cannot raise the produce to support the inhabitants. The consequence is that prices are higher on many articles than they would be in New York, Philadelphia, or Pittsburg. This excess of charge is more ap-

parent on luxuries. Necessities are usually reasonable, but cheap jewelry, fancy cravats, and the like, are apt to be high.

This much can be said of all classes of these stores—that the goods sold are of good quality and are what they are represented to be, and that they are conducted in a way to impress themselves upon one as being model business enterprises, in that they are invariably well housed and kept in the pink of neatness and order.

Closely associated with the company store in the meed of condemnation which it has received is the miner's house. Here it runs the whole gamut, from a mere shelter to a substantial and comfortable dwelling. Single men are apt to live in a shack of one room, substantially built to be sure, and capable of being kept warm and comfortable, but far from being an abode of luxury. Here the miner sleeps and possibly does his own cooking, though he frequently boards. For the married men, the three-room house is most common; it is usually well built and can be made comfortable, though its surroundings are far from attractive and are frequently dirty.

One of the largest companies operating the field erected very comfortable miners' and employees' houses, with the hope, though hardly the expectation, that they would lead to a higher standard of living among the men. Especial pains were taken with the three-room cottages. The rooms were fairly large, and in addition there was a small stove room with a flue, and a place to wash. It was expected that a small stove would be placed here, and that, when the miner returned from his work, his wife would have a fire and hot water ready for him; that he would wash, change his clothes, hang his working suit in this place, and then go to his living rooms a clean and comfortable man. This was of course, explained to the tenants, with results that were far from encouraging. A visit of the house inspector, shortly after the occupancy of the premises, showed that the families were practically living in one room; that the small wash room, from which it was expected so much comfort would be derived, was used by the children as a closet; that the other rooms than the living were used for similar purposes; that the open miner's lamp had been hung from a nail driven into the wall and had smoked the room black; and that the broad porch before the house had been fouled with slops and refuse. It may be added, however, that such a condition is by no means universal, and there are many of the miners' houses that are kept neat and clean. Here, as elsewhere, this is a personal matter, and it is solely in the hands of the individual as to whether his environment shall be clean or filthy. But, with the possibility of such treatment as that detailed

staring them in the face, it is a small wonder that the companies are so loath to build better.

The rents charged for these houses average about $2.00 per room per month, though there are many one-room houses rented to single men for $1 a month.

In this connection it may be well to mention the list of charges that are carried against the men on the books as regular items. These are doctor, smithing, mine checks, and electric lights. For the company doctor the single men are charged 50 cents and the married men $1.00 a month, which pays for the privilege of summoning the doctor at any time, and for all medicine. A smithing charge of 50 cents a month is entered against every miner, and pays for the sharpening and dressing of his tools, with no extras. For the mine checks, or checks that the miner hangs upon the car, when loaded, a deposit of 10 cents each is required, which is refunded when the checks are returned. As many of the houses are fitted with electric lights, a charge is made for this dependent upon the number of lamps. A fairly average rate is 50 cents per month for one; $1.00 for two; $1.45 for three, and then rapidly decreasing until at $3.00 ten are supplied, after which the rate is 5 cents per lamp. Of course these latter rates do not affect the average miner and workman, who rarely has more than three.

In this review no attempt has been made to cite special instances of prosperity or misery, of lawlessness or upright living, of oppression or paternal care, but merely to give an idea of the average social conditions prevalent in the region and to show, in some measure, the reasons for the existence of these conditions as they are. From what has been said it will be seen that the place is no paradise, but that the necessities and comforts of life are well within the reach of the wage earner, if he can only be prevailed upon to take advantage of his opportunities. Unfortunately for him and for all concerned, his standard of living is low, and it will take time to educate him out of his present methods. Sanguine observers hope for an improvement in the Hungarian and Italian in a generation, but they doubt if the negro will show much improvement in less than three or four. At present the region is rough but not dangerous, and in this respect is constantly improving through the unceasing vigilance of the companies. It can never become a prosperous farming community on account of the roughness of the country, but that it might be made attractive to tourists is more than probable, through an improvement in the present wretched hotel accommodations; for certainly one would travel far before a more beautiful place could be found than this.

SYSTEMS AND METHODS OF MECHANICAL REFRIGERATION.

By Sterling H. Bunnell.

THE refrigerating machine, of whatever type, is nothing else than a reversed heat engine. Its cycle consists of the compression of a suitable medium, the removal of the consequent increase of sensible heat by circulating water, and the reception of heat by the cooled medium under a reduced pressure and corresponding low temperature, from the relatively cold body to be refrigerated.

This cycle is the basis of all mechanical refrigerating devices. The refrigerating medium may be a "permanent" or not conveniently liquefiable gas, or any of the fluids more readily changed between liquid and gaseous states. Since fluids of the latter class, by reason of the phenomena of latent heat, are able to take up during evaporation much greater quantities of heat per pound of gas handled than non-liquefiable gases can during mere expansion, much smaller quantities of the liquefiable refrigerants need be compressed per heat unit to be removed from the refrigerator. Aside from mechanical and other practical losses, all liquefiable gases work with equal efficiency in refrigerating machines, so that the selection of the best medium depends entirely on practical considerations.

Motors on the principle of the steam engine have been constructed to operate with various vapors, such as naphtha, alcohol, and even carbonic-acid gas. Refrigerating machines as well can be operated with any of a number of media, of which the most suitable are water, ether, methyl chloride, sulphur dioxide, "Pictet fluid," (a mixture of sulphur and carbon dioxides,) anhydrous ammonia, and carbon dioxide. The ideal refrigerant should liquefy at convenient temperatures under moderate pressures, and evaporate at suitable refrigerating temperatures at pressures not too low to allow of easy compression of the gas by single-stage cylinders back to the liquefying pressure, and besides should be neither inflammable, explosive, chemically active upon common metals, dangerous to life or property in case of leakage or accidental escape from the apparatus, nor expensive to purchase. In the case of the steam engine, water is so much the best working medium that others have been used only to a limited

extent in motors for special purposes. The reversed heat engine is reversed in this particular as well, for water is in practice the most uneconomical of refrigerants, while no other substance is universally agreed to be the best.

The compression process may be broadly said to cover all the systems of refrigeration by mechanical means. The apparatus comprises a compressor, a condenser in which the compressed and heated refrigerant is brought into the liquid state by cooling with circulating water, and a set of expansion coils in which the liquid refrigerating medium is allowed to expand under a low pressure and corresponding temperature and derive the necessary heat for its evaporation from the surrounding substances to be cooled. The dimensions and details of compressor and piping may differ with the gas used, but the principles are identical. Most common and some rare fluids have been considered with a view to service as refrigerants, and many have been actually tried; but only about half a dozen have been commercially used and exploited by manufacturers. Ether and some other volatile substances evaporating under atmospheric pressure, particularly in a current of air, at freezing temperatures, suggested the artificial production of ice and were the subjects of the earliest experiments. As the theory was developed the advantage of denser mediums became apparent, and refrigerating pressures rose with steam pressures, as other fluids were tried, until today one widely-used system carries without difficulty pressures sometimes higher than one thousand pounds to the square inch. It is convenient to consider the systems in the order of the condensing pressures carried.

First in this classification is water vapor, the medium of the so-called "vacuum ice machine." An air-tight chamber provided with a removable cover is exhausted by an air pump—a compressor—to a pressure below .089 pounds per square inch absolute. Water is introduced into the chamber in a spray, and part evaporates under reduced temperature, the vapor being continually pumped away, until in supplying the latent heat necessary for the evaporation the remainder of the water forms ice. When a sufficient quantity has formed the chamber is opened and the ice cake removed, after which the process is commenced as before. The theoretical capacity of the compressor is 866,580 cubic feet per ton of ice formed, and as this great volume of vapor is compressed under an extremely light pressure, the mechanical efficiency is very low. The duty is much improved by compressing the vapor to 1½ pounds per square inch absolute and then condensing it as with steam engines, instead of delivering it as vapor under atmospheric pressure. Another way is to absorb the vapor in

sulphuric acid, treating the acid to remove the dissolved water and using it over and over.

These machines are not in commercial use and thus far have not attracted the attention of purchasers. The obstacles heretofore insurmountable are the impossibility of making transparent ice, the minute quantity of dissolved air expanding under the reduction of pressure and forming very objectionable bubbles; the difficulty of making satisfactorily air-tight joints at the covers of the evaporators and elsewhere; and the inefficiency of compressors handling air at extremely low pressures, or the complications and manifest objections introduced with the sulphuric-acid system.

Next in order to this direct method come systems using gases liquefiable at pressures not unlike those of the steam engines contemporary with these machines. Ether was the favorite with inventors working in the period from 1834 to 1865; naphtha, chimogene, carbon bisulphide, methylic ether, and possibly some others were subjects of later experiments. At refrigerating temperatures all these liquids evaporate at pressures below atmospheric, so that any leakage causes the introduction either of air, with consequent disturbance to the condensing process, or of water or brine, which is likely to make trouble in other ways. The gases are subject to chemical dissociation under heat and pressure, or in combination with water leaking into the pipes may form other chemical compounds; while some of them are inflammable, poisonous, or corrosive. Finally, such tenuous gases require excessive cylinder capacity in the compressor, and must be worked under high ratios of compression with all the attendant mechanical difficulties and inefficiency. For these and other reasons the art has advanced to the use of gases requiring higher pressures.

Modern practice accordingly employs such media as sulphur and carbon dioxides and the Pictet mixture of the two, anhydrous ammonia, and even common air. Sulphur dioxide was put into practical use by Pictet in 1876, and is the preferred medium of several prominent European builders, though never extensively employed in America. It has no chemical affinity for metals or oils, is incombustible, cheap, and a fair lubricant. At ordinary temperature the condensing pressure is under 60 pounds per square inch, and the required evaporating pressure is somewhat below atmospheric. Leakage in submerged expansion coils therefore permits the entrance of water and the formation of sulphuric acid, with resulting rapid destruction of the apparatus. In the effort to improve the efficiency of his machine Pictet invented the mixture of 97 per cent. sulphur dioxide and 3 per cent. carbon dioxide, known as "Pictet fluid" and used by several

Continental manufacturers. As used for refrigeration this compound does not follow the law of perfect gases, having evaporating pressures higher at refrigerating temperatures and lower at condensing temperatures than sulphur dioxide alone. Greater efficiency is claimed in accordance with this peculiar behavior, and explained by the theory of a chemical combination between the mixed gases under condensing pressure and a corresponding dissociation under low temperature and pressure. There is not enough positive information for discussion of this theory. The few recorded tests show inconsiderable differences between this combination and sulphur dioxide alone.

At present, the majority of refrigerating machines employ as their medium anhydrous ammonia. The condensing pressure required with this gas is from 150 to 200 pounds per square inch, and the evaporating pressure from 15 pounds upward above the atmospheric. The ratio of compression is thus six or eight to one, almost enough to make two-stage compression desirable, and requiring for single stage operation particular care in designing valves, cylinder, and piston so as to minimize clearance losses and leakage. Ammonia is in many ways an ideal refrigerating medium, being cheap, efficient, and chemically stable. But its chemical activity prevents the use of copper, zinc, and brass for pipes or fittings, and compels making all apparatus of iron or steel exclusively. The superior heat-conducting power of copper and its alloys, and their durability under the action of water and moist air, particularly at sea, cannot be secured in a machine using anhydrous ammonia. The odorous and poisonous nature of ammonia gas is very unfortunate, since any slight derangement or accident causing leakage produces an atmosphere in which men cannot live, except when protected by diver's helmets or similar apparatus, destroys any food products which may be reached by the odor, and permeates the walls and casings so as to require an expensive process of ventilation, disinfecting, and repainting. Accident to an ammonia apparatus is usually followed by the flight of every person in the building and immediate vicinity, and too often by the death of the men at work near the leak or escape. Fires in cold-storage plants generally cannot be checked before serious damage is done, because the firemen know that the first falling pipe will spread the deadly gas everywhere and cause the death of all who are not in a position to flee instantly. Ammonia escaping during a conflagration is inflammable and may even be explosive, though under other conditions it seems to have a tendency to extinguish fire. Safety valves to relieve excessive pressure being inadmissible, the best insurance against accident lies in providing a great margin of strength.

When ammonia refrigerating machinery is used on shipboard, approved practice provides for the plant a separate compartment and force of engineers—an inconvenient arrangement which only mitigates the dangerous results of accident, and adds another argument in favor of the safe carbonic-anhydride or compressed-air machines.

The prevention of odor about the apparatus being then the great difficulty, the designer of ammonia machinery must produce an apparatus able to hold 200-pounds gas pressure without perceptible leakage. To prevent ammonia odor at stuffing boxes, some makers build single-acting cylinders, so as to carry a low pressure on the packing; others provide an oil-seal, and others enclose single-acting cylinders, pistons, cranks, and shaft in a hollow case and provide packing around the crankshaft only. Stuffing-boxes are always made extremely long, and the packing sometimes comprises a sleeve or lantern supplied with oil under pressure. Variation in the amount of liquid present in the gas coming from the evaporating pipes causes change in temperature and tension of packing, so that glands may need frequent attention. These problems have been variously solved, but even yet freedom from objectionable odor from machines operated in or near rooms occupied by men is at the cost of much expense and attention from the operators. There is usually some loss of ammonia not traceable to perceptible leakage, due to overheating during compression and consequent chemical action between ammonia and lubricating oil, resulting in the formation of permanent gases in the condenser and the loss of the ammonia thus transformed by the necessary blowing-off; this waste with that due to necessary blowing-off to clear foreign matter from coils often runs as high as one charge of ammonia in a year.

Anhydrous ammonia is used in another system, performing refrigerating work in the same way, but avoiding mechanical compression of the gas by use of the principles of chemical solution. This, the absorption system of Carré, is next to the ammonia-compression system in number in use, and has certain special advantages that will be set forth. The system involves condenser and evaporating coil, as with the compression type, but in place of the compressor is an absorber in which a weak solution of ammonia in water takes up the ammonia gas from the evaporator. From the absorber the strengthened solution is passed through an interchanger to the still, where continuous application of heat drives off the ammonia under pressure, the gas passing to the condenser as with the other system, and the liquid, now hot and again a weak solution, being returned through the interchanger to the absorber. The office of the interchanger is to transfer heat from the weak, hot liquid to the strong,

cold solution coming from the absorber. Much of the heat expended upon the solution in the process of driving off the gas is thus saved and used in warming the next portion to be treated. To do its best work the absorption system requires more cooling water than other methods, which is in some cases an objection to its use.

The only moving machine required in the absorption apparatus is the small pump which transfers the strong liquid from absorber to still against the condensing pressure of the ammonia. As the degree of heat required for the still is not great, exhaust steam may be used for heating and for running the pump, and the absorption refrigerating apparatus may be thus installed alongside steam engines and operated at extremely low cost. In modern hotels and office buildings quiet is essential and exhaust steam plentiful, so that the absorption refrigerating machines fits well into such places.

The special disadvantages of this system are, first, the objections to ammonia in itself, already enumerated, and second, the difficulty of operation and maintenance. For instance, too much heat at the still drives water over with the ammonia, similarly to the priming of a forced steam boiler, and may force out the weak liquor too rapidly and lower the level in the still. In the first case, ice will be formed in the refrigerator coils and choke or close them; and in the second, the working conditions of the plant will be disturbed and much care must be given to restore them. Deterioration goes on more rapidly than with anhydrous ammonia, so that the apparatus needs overhauling at frequent intervals.

Progress seems to have been in the direction of increasing pressures of gas, with corresponding increased density and decreased cylinder volume in the compressor. The step from sulphur dioxide at 60 pounds to ammonia at 180 to 200 involved the exchange of a distinctively low pressure for one considered decidedly formidable, even for the comparatively harmless steam, and necessarily much more so for a dangerous gas such as ammonia, where no simple safety valve can be used. The next step was a long one in the matter of pressure, but justified by the fact that the refrigerating medium thus put in use, unlike steam and ammonia, is entirely harmless. Of the cheap and common gases carbonic anhydride comes next to ammonia in condensing pressure, but with the formidable figure of 800 to 1,200 pounds per square inch under ordinary temperature conditions. Otherwise the gas is absolutely ideal, being dense, odorless, practically harmless, cheap, chemically inert, and low as to its freezing point. These marked advantages induced the original designers to attempt the development of means to cope with the heavy pressures,

and the result has been perhaps the most promising system of refrigeration now in use.

Most works on refrigeration dismiss the carbonic-anhydride system with a brief mention of a well-known English manufacturer and a vague allusion to other foreign constructors not named. It is true that European manufacturers took up the manufacture of the carbonic anhydride apparatus several years before its development was begun in the United States; but there are now three or more American shops offering these machines, while the total number in use throughout the world is probably over two thousand. The majority of these plants are on shipboard, but their use for cold-storage work on land is being rapidly extended.

The carbonic-anhydride refrigerating apparatus must be constructed primarily for strength, but the smaller size of pipes and cylinders required compensates for greater proportionate thickness by keeping down the total weight and space occupied, considerably to the advantage of this system. The absolute tightness of the pipe system is easily secured by metal gaskets in strong flanged joints. The piston-rod packing presents the only chance for possible leakage, and its tightness is insured by the use of cup-leather packings sealed by oil supplied under pressure by a small pump and accumulator cylinder. The oil pressure is maintained somewhat higher than the maximum gas pressure in the cylinder, so that leakage may take place into the cylinder from the oil chamber rather than outward from the gas in the cylinder to the atmosphere. One patented arrangement provides a compound packing, the interior cup leather being placed just beyond a gas chamber, through which any gas escaping from the cylinder past the leather may return to the suction side of the machine; and the usual oil-chamber with its cup leathers is provided outside the gas-intercepting space, where only the suction pressure has to be held, instead of the entire discharge pressure as in the case of the usual single packing. As carbonic anhydride is inert, copper and bronze are used wherever convenient, a great advantage in producing a non-corrosive and almost indestructible apparatus, particularly where sea water is used for condensing purposes.

Carbonic anhydride is permanent under all conditions of a refrigerating apparatus, and will neither dissociate nor combine with oil or any other substances used about the plant. The pure gas as used by bottlers, unlike the exhaled product of animal respiration, is entirely harmless as well as odorless, and while it will not support life, it is absolutely inappreciable in its effects, even if liberated in quantity in an ordinary closed room. In addition to other desirable

qualities is its value as a fire extinguisher. The ratio of compression in carbonic-anhydride machines is very low—only two or four to one—and therefore very much in favor of economical performance of the compression part of the cycle, as compared with the inferior efficiency of machines of other systems operating under a much greater ratio.

It should here be noted that all liquefiable-gas systems suffer a loss of useful refrigerating effect by the cooling of the liquid from the condensing to the evaporating temperature. The condensed gas leaving the condenser at, say, 70° must be itself cooled to the evaporating temperature immediately after passing the expansion valve as the evaporation commences, and the heat thus given up by the liquid diminishes the useful effect of the evaporation in cooling the desired substances around the pipes. The loss of efficiency could be avoided by evaporating the liquid in part and doing work on a piston, the heat given up being thereby converted into work; but this would introduce a complication not warranted by the very small saving possible. As carbonic anhydride in the liquid state has a density and specific heat much greater than those of other gases used for refrigeration, the loss in this system from the cooling of the liquid is greater than in the others; but it is more than compensated by the superior efficiency of the compression process, with the dense gas and low ratio.

Last in order of liquefying pressures comes air. Liquid air when first produced on a large scale was claimed to possess superior refrigerating value, but figures soon showed that no such enormous quantity of refrigerating effect as alleged could be stored up in small compass, and the impossibility of liquefying the air by natural cooling without expensive mechanical processes disposed of the project. Common air is, however, used in refrigeration by simple compression, cooling, and subsequent expansion doing work against a piston, the latter process being required to dispose of the heat carried by the air, by converting it into mechanical work. In the earlier method, atmospheric air from the storage rooms was compressed to about 65 pounds per square inch, the resulting sensible heat being removed by circulating water, and then expanded to atmospheric pressure against a piston connected to the mechanism so as to return the work so developed to the apparatus. The air leaving the expansion cylinder at a temperature of 60° to 80° below zero was then led through the "snow box" in which the moisture carried thus far was deposited, the latent heat liberated by the vapor in the process of condensation and freezing raising the temperature of the air 20 to 60 degrees in passing the length of the snow box. This rise in temperature without useful effect was to the enormous disadvantage of the process, being about

one-fourth to one-half of the total possible range of temperature from the minimum in the expansion cylinder to the cold-storage temperature to be produced.

By confining a quantity of air and working it in a closed cycle, the moisture once deposited would be finally eliminated instead of being replaced by evaporation from articles within storage rooms, as in the first method. The resulting gain in efficiency could be greatly increased by raising the pressures under which the confined air should be worked. This process constitutes the "dense-air" system of refrigeration, and is extensively used on shipboard. As compared with the simple compression machine using liquefiable gas, the dense-air apparatus seems complicated, requiring one compressing, one expanding, and one make-up cylinder (to replace leakage) besides the power (usually a steam) cylinder. The lack of the effective latent-heat principle causes the refrigerating effect per cubic foot of cylinder displacement to be very small compared with the liquefiable gas process, so that in comparison the several cylinders must be very large for equal refrigerating capacity, and the weight and space occupied is excessive, while the efficiency is low. For these reasons the air machine is only advocated for use on ships where its independence of a reserve supply of any special chemical and its use of a harmless refrigerant are of advantage. The low-pressure air machine is no longer built, having been entirely superseded by the dense-air type.

Summarizing the three refrigerants in common use, ammonia is seen to have good efficiency and moderate pressure, but most dangerous effects in case of accidental escape; air, very low efficiency and excessive weight, bulk, and complication of apparatus, but moderate pressure and entire absence of objectionable qualities in the refrigerant itself; while carbonic anhydride affords an efficiency slightly superior under ordinary conditions to that of the ammonia system, pressures (while the highest of any common refrigerant) by no means so high as to be unmanageable or dangerous, and at the same time the lightest and most compact of machinery, made with non-corrosive metals wherever desirable, and these with a gas that is readily and cheaply obtained in all important cities of the world and is entirely harmless under any conditions of use, misuse, or neglect. Assuming that carbonic anhydride has no advantage over anhydrous ammonia in respect to first cost of apparatus, power, weight, and space occupied, and that the expense of replacing leakage is as great—all of which conditions seem in practice to work out more or less in favor of the former refrigerant—the carbonic-anhydride system insures maximum safety to men and materials in the neighborhood, under

no matter how serious an accident or emergency, while the presence of ammonia under pressure is a constant menace to operators and stored property alike.

Passing from the development of the refrigeration to its application, the methods used are found to apply alike to all systems of refrigeration. The cooling of the metal expansion pipes by the evaporation of liquid therein is always the first effect produced. The pipes may be located in the rooms to be cooled, and transfer the effect to the air by conduction and convection—the direct-expansion method; or they may be submerged in water or a solution of sodium or calcium chloride, and this in turn circulated and used as a heat-carrying medium—the brine-circulation system. Sometimes the pipes are arranged in banks, either within the rooms or elsewhere, and air circulated through the rooms by fans or a central blower and system of ducts. By arranging a sufficient amount of cooling pipe and racks, meat or fish may be frozen solid and thus preserved indefinitely by storage at 10 to 15 degrees above zero Fahrenheit.

Small machines are used in cooling work rooms, offices, and candy factories, and might equally well be used in cooling living rooms in large summer residences. The cost of such cooling is generally supposed to be too high to be borne, except where, as in workrooms, substantial cash compensation obtainable in no other way can be had. A pound of coal used in steam-heating a room may deliver 8,000 to 10,000 B. T. U., but in refrigeration on a small scale may only remove 1,700 B. T. U.; so that if average winter weather requires heating a building 50 degrees and average summer weather requires cooling the room 10 degrees to a desired temperature of 70 degrees, it would cost no more for coal to cool in summer than to heat in winter. The necessary machinery would require more expensive attendance than a heater, and with a very small plant the duty would not reach 1,700 B. T. U. per pound of coal. The cooling of theaters and audience rooms is greatly to be desired, but as the heat emitted by the human body is about 400 B. T. U. per hour, enough to warm a crowded house in winter weather without the aid of a heating plant, the necessary refrigeration in hot summer weather would cost much more than the usual running expense of the heating apparatus in winter. Supposing the performance of cooling equal to the melting of 12 pounds of ice by each pound of coal burned, there would be required for each 1,000 persons a refrigerating capacity equal to the melting of 34 tons of ice in twenty-four hours, and requiring the consumption of 225 pounds of coal per hour. As the engineering problems are very simple, the comfortable theater may yet be the fact.

The other great field of mechanical refrigeration, the one for which the art was first developed, is the making of ice. There are now two principal systems, known as can and plate, the first freezing water contained in open cans of sheet iron floated in refrigerated brine, and the second forming ice in sheets on the sides of cooled metal plates immersed in water. Clear crystal ice being demanded by the market, the dissolved air which would form bubbles during freezing and make the ice white must be driven off, by simply agitating the water in cans or plate ice tanks through the medium of compressed air jets or agitating wheels, rarely by continually rocking all the cans by mechanism, or by previously distilling all the water used for making ice. The latter process insures the purity of the water and is regularly used with the can system, exhaust steam from the engine which operates the plant being condensed, filtered, and cooled for use in the ice cans. This does not mean that the economy of the best condensing engine can be obtained, since the water of condensation must be violently reboiled to remove the remaining air and drive off impurities, and is therefore condensed at 212° and under atmospheric pressure; in fact, to obtain the necessary one-fourth ton of water and the additional quantity lost in reboiling and skimming, steam to the amount of 5 or 6 pounds per horse-power hour must be provided and may as well go through the engine as be taken "live" from the boiler. When naturally pure water is at hand, the plate system is therefore preferred, steam being unnecessary for ice making, so that the machinery can be operated by an economical steam engine or by water or other power. The 300-pound cake of can ice is frozen in about forty-eight hours, whereas plate ice 11 inches thick is from ten days to two weeks in forming; which means that in the plate plant more than five times the quantity of water is in process of treatment, and the space and first cost is much greater than for the other system.

Ice cans are lifted one or more at a time by hand or power cranes, and either dipped or sprinkled with water until the ice cake slips out, in modern plants to slide without manual labor through an automatic door into the storage room, registering its passage on the way to tally the output of the plant. Plate ice is loosened by substituting either hot gas from the compressor for the liquid evaporating in the hollow metal plates (the resulting liquid being used in other parts of the plant with that produced in the regular condenser,) or substituting warm brine for cold brine where brine plates are used; or by cutting the slabs of ice free by mechanical saws or by small steam pipes which melt their way through the cakes. The loosened plates,

weighing five to ten tons each, are lifted by a crane and subdivided by saws or steam cutters into marketable pieces. Plate ice is beautifully clear and transparent, while can ice, being formed of radiating crystals, is generally more or less translucent in the interior and has whatever air or impurities may be present concentrated at the center. The purifying apparatus of the can plant requires continual care to avoid rust, dirt, and defective operation, while the plate-plant engineer has the problem of freezing good corners and detaching the large brittle slabs without cracking them, and of managing to have the proper number of plates of full thickness ready each night for the next day's demand. With the best apparatus and competent workmen, the cost of manufacturing ice is less with the plate than with the can system.

Most of the ice manufactured is used in refrigerators, many of which could be profitably cooled by direct mechanical refrigeration. The use of small independent plants in markets, hotels, and saloons is rapidly increasing. In some thickly settled districts there are companies circulating cold brine through underground pipes in the streets to refrigerators in neighboring buildings, and doing a profitable business in spite of the heat loss through the pipe covering. It has been proposed to circulate some liquid refrigerant, returning the gas to the central station; but as leakage would be highly dangerous in case of ammonia, and expensive loss of gas practically certain to occur in inaccessible underground pipes under the pressure necessary with carbonic anhydride, the problem is as yet too difficult.

The cooling of refrigerator cars by ice at enormous expense and at the cost of valuable freight space is a wasteful and ineffectual method of preserving meat during transportation. Refrigerating machinery has been at last applied to this service, and lines of mechanically cooled cars will probably soon be in operation. The successful machine is carried under the car body, driven from one of the axles. and applied to freezing ice in narrow tanks by the carbonic-anhydride system. The condensing devices used on these cars are highly ingenious in detail, though the principle is the familiar one of evaporating on the surface of the condensing pipes part of the water from a small supply carried in a tank along the car roof.

Refrigerating and ice-making machines have already taken their place with steam engines as machines with well-known principles of design and construction, manufactured by various shops in nearly every state in the country. Their general sale and use has undoubtedly added very greatly to the general comfort and health, and decreased the cost of living, by providing means of preserving and transporting perishable food products.

WAGE-PAYING METHODS FROM THE VIEWPOINT OF INVESTED CAPITAL.

By Henry Hess.

With this article Mr. Hess concludes his very interesting graphic study of the effect of various wage systems, which began in our issue for April last. The object has been not to dogmatize, but to develop the facts. Comment from the authors of the various plans or from those who are using them will be cordially welcomed by Mr. Hess and by the editors of the Magazine.

IN the preceding chapters of this discussion (in this Magazine for April and May, 1904), the effect of various methods of wage payment on the workman's wage and on the profit and loss account was considered. The first paper dealt chiefly with the more immediately apparent interests of the workman who lends his services in return for as large a wage as he can secure; the second paper went into the question from the standpoint of the manager, standing between the workman and the capitalist; the latter's interests as affected by the wage cost under various methods of remuneration for enhanced speed of working, form the basis of this concluding chapter.

As it is clear that capital will favor that method which secures the highest interest return while employing the least total amount, the investigation is directed toward determining the relative value of the various wage-paying methods in this regard.

In order to avoid the difficulty of digestion of long columns and tables of figures, the graphic representation of results is made use of. While rates of pay and the relation of wages cost to material and expense vary decidedly in different industries, yet the general results will be similar, though the numerical values will vary. As a fairly general average for machine building a wage cost by day pay of 25 cents per hour, a general expense of 30 cents per hour, and a material cost of 40 cents per hour will answer, and have been taken; it has been further assumed that the product of one hour's work, under ordinary day pay and ordinary rate of production, is sold for $1.00.

Chart 6 (reproduced from the previous chapter) illustrates graphically the results for day pay. At the centre of the base scale 1 stands for one hour occupied; to the left of this are figures giving lesser amounts of time used, down to a saving of all the time at zero; to the

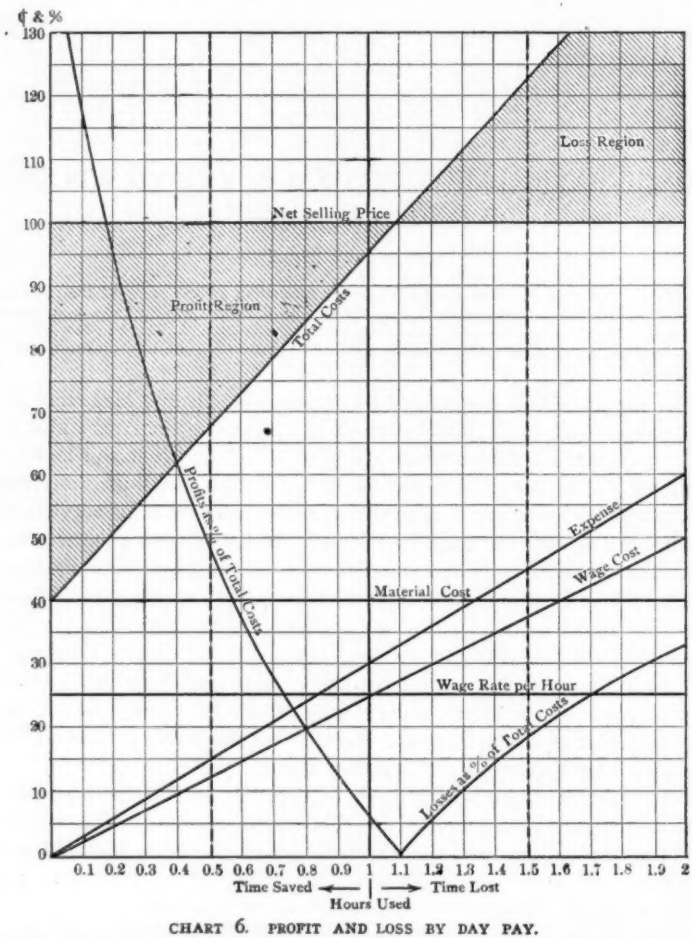


CHART 6. PROFIT AND LOSS BY DAY PAY.

right are figures giving the time used in excess of the one-hour basis, up to a maximum of two hours. The vertical scale at the left is marked in cents and per cent. Since with day pay the wage rate per hour is constant, the wage cost of the work will be proportional to the actual time used; a diagonal line starting from zero cost at zero time and laid through 25 cents at one hour will represent the wage cost for all possible time between zero and two hours; thus, tracing from 0.5 hours at the base scale vertically upward to intersection with the

"Wages Cost" line, and then referring to the scale at the left, gives a wage cost of 12.5 cents. A similar diagonal marked "Expense" gives the expense cost incurred for the time used. As material cost is constant for any piece of work and not variable with the time taken to do the work, it is represented by the horizontal line marked "Material Cost" at 40 cents. The total costs are found by summing up the three elements of wages, expense, and material cost, and are represented by the slant line starting from 40 cents at the left-hand scale and marked "Total Costs." As the selling price is fixed by general market conditions rather than by the varying individual manufacturer's cost, it will be represented by a horizontal line, in this case at 100 cents. So long as the total costs are less than this selling price, there will be a profit, indicated on the chart by the total-cost line lying below the selling-price line, while the amount of the profit is shown by the vertical distance between the two lines. Thus at 1 hour there is a profit of 5 cents; with only 0.5 hour taken this profit rises to 32.5 cents. Loss is indicated whenever the total-cost line rises above the selling-price line—in the example this occurs whenever more than 1.1 hours are occupied in doing the work.

Since invested capital reckons its returns on a yearly basis the results are to be considered for a year's work. The working year is made up of 300 days of 10 hours—3,000 working hours. At the base time of one hour, the year's total costs are $3{,}000 \times 0.95 = \$2{,}850$. The year's returns at the net selling price of \$1.00 for the basic hour's output is $3{,}000 \times 1.00 = \$3{,}000$; the year's profit is, therefore, $\$3{,}000 - \$2{,}850 = \$150$. The total capital actually employed is equal to the total cost of the year's product; the \$150 then represent a profit on that capital of 5.3 per cent.*

Since time saving results in a saving of wages and expense cost, it is evident enough that such saving will be attended also by an increased interest return on the capital. At a saving of one-half the time, Chart 6 shows the profit on the job to be 32.5 cents; the profit on 3,000 jobs is $3{,}000 \times 32.5$ cents $= \$975$; the total cost per job is 67.5 cents and the actually employed capital is, therefore, $3{,}000 \times 67.5$ cents $= \$2{,}025$; as the work is completed in one-half the old time, this capital is employed only a half year and the interest returns therefore are $\frac{975 \times 100}{2{,}025} \times 2 = 96.3$ per cent. The profit returns

* Whether or not this is correct depends upon the rate at which the detail costs are incurred and the way in which the sales returns come in. As the purpose of this investigation is comparative and since the assumption made above will not change relative values, that assumption is permissible.

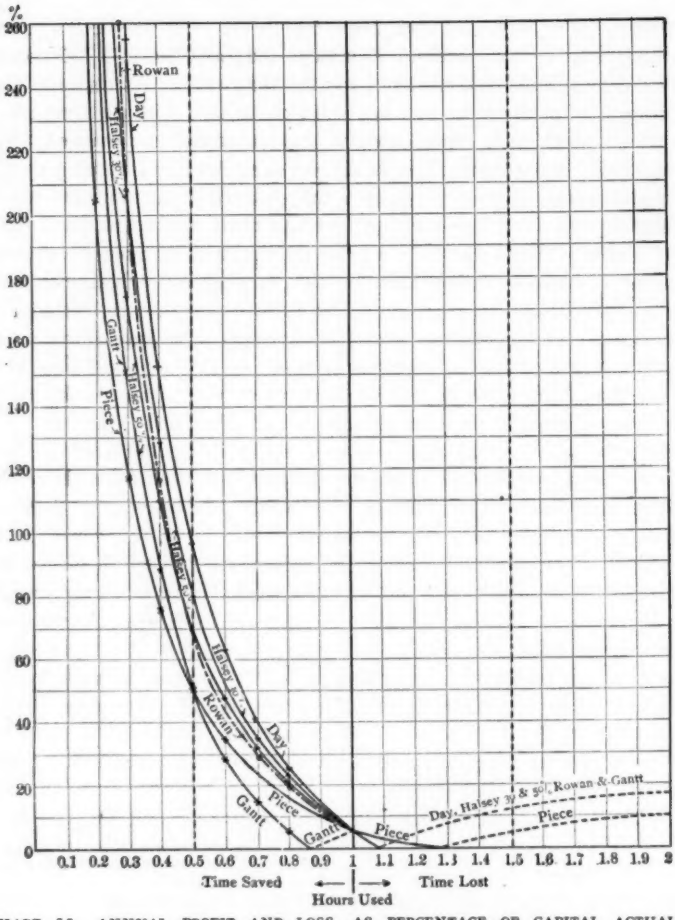


CHART 13. ANNUAL PROFIT AND LOSS, AS PERCENTAGE OF CAPITAL ACTUALLY EMPLOYED, BY TIME SAVINGS UNDER VARIOUS METHODS OF WAGE PAYMENT.

for various time savings are calculated similarly and then plotted on Chart 13; the characteristic line is the curve marked "Day Pay," in this chart; also, the lower scale refers to the time saved and the vertical scale to the per cent. of interest returns. Were it generally possible to induce men working by the day to exert themselves continuously so as to save time, then day pay must necesarily result in higher returns to invested capital than any other method of wage payment involving

a sharing of the money value of the time saved. As that is, however, rarely possible, and in fact contrary to human nature, various methods have been devised having the common feature of an extra wage recompense for extra exertions.

Of these the most widely adopted is "Piece Work"; under its operation the entire wage-cost saving goes to the workman, while capital retains as its share the values in savings in general expense, and the enhanced earning capacity attendant on a more frequent turn-over.

A curve characteristic of piece work is plotted on Chart 13; its derivation is analogous to that explained for day pay; the elements are shown in Chart 10, page 184 of the May number of THE ENGINEERING MAGAZINE. A comparison of the curves on Chart 13 shows that the returns for piece work are decidedly less than with day pay throughout the region of time saved. On the other hand, since the day-pay curve return reaches zero at a time loss due to the occupation of 1.1 hours, and this point of no earnings is reached by piece work only after 1.27 hours are taken up, it is evident that piece work favors capital when time is lost; a comparison of the loss curves further confirms this conclusion. The reason is very simple; the piece worker shares in the loss attending time loss to the extent that such time loss reduces his wage rate; this is a logical corrollary to his sharing in the savings to the full extent that such time savings increase his wage rate and return.

Of the other systems, the Halsey premium plans share the wage-cost value of time savings between the employee and the employer in varying ratios; two arrangements are in very general use, of which one awards the workman 30 and the other 50 per cent. of the wage value of the time saved as a stimulus and reward for increased effort. A modified premium plan—the Rowan—so arranges the premium that the wage rate per hour is inversely proportional to the time saving, in such way that the wage return per hour would be exactly doubled if the time were reduced to zero. (See also page 31 of the April issue of THE ENGINEERING MAGAZINE.) The Gantt plan provides a very considerable bonus as a stimulus to the attainment of a time set as short as close study shows may be attained by a good man.

All of these plans, except piece work, assure the workman day pay when time is lost; hence the coincidence of their time-loss curves.

On Chart 13 curves characteristic of all these various plans are plotted.*

* Charts, similar to number 6 for day pay, containing the elements for the various other wage-payment plans, are given on pages 172 to 186 of the preceding chapter in the May issue of this Magazine.

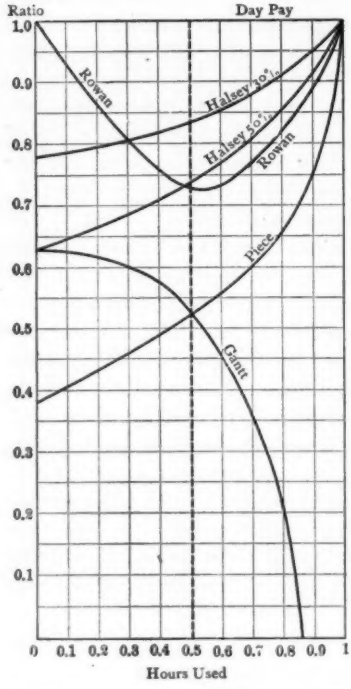


CHART 14. RELATIVE PROFITS, IN PERCENTAGE OF ACTUALLY EMPLOYED CAPITAL, BY TIME SAVINGS UNDER VARIOUS METHODS OF WAGE PAYMENT.

It is not to be expected that time savings beyond one-half will be often realized; for this reason the region beyond is cut off by drawing a heavy dotted line on the chart from 0.5 upward. For time savings up to one-half the curves show that the 30 and then the 50-per cent. premium plans give results approaching in interest for capital that of day pay; then the Rowan plan makes a fair third, and, in fact, at one-half time coincides with the Halsey 50-per cent. The results under piece work fall decidedly short, and those under the Gantt plan still more so, particularly in the region of the smaller and, therefore, more readily attainable time savings; at one-half time the Gantt plan gives the same results as piece work, and better than this for greater savings.*

Readings from the curves showing the values of various plans in interest returns on the capital actually employed at a few time savings are given in the small table as follows:

TIME SAVINGS.

Plans	1	0.75	0.5	0.35
Day	5 per cent.	33 per cent.	97 per cent.	258 per cent.
30 per cent.	5 "	29 "	80 "	208 "
50 per cent.	5 "	25 "	70 "	177 "
Rowan	5 "	23 "	70 "	207 "
Piece	5 "	19 "	50 "	118 "
Gantt	5 "	10 "	50 "	152 "

On Chart 14 the value of the various plans is illustrated by curves giving their ratios with day pay, when the latter is taken as a unit;

* The bonus for the Gantt curve given is 50 per cent. of the normal day-pay wage; with lesser bonus the interest returns will rise. This method is employed by its originator only in connection with a very thoroughly worked-up system of supervision and instruction, insuring the attainment of large time savings.

thus at a time saving of one-half the interest returns are 1 for day pay, 0.83 for Halsey 30-per cent., 0.73 for Halsey 50-per cent. and Rowan premium, and 0.52 for both piece-work and Gantt bonus plans. This chart also shows quite clearly the point made by the originator of the Rowan system—its value in raising the returns to capital when time savings are increased materially beyond one-half. Mr. Rowan takes the position that such savings are realizable only by the introduction of improvements in plants and methods outside of the workman's control and entirely at the employer's expense, so that in all fairness the latter should again share more largely in the returns. In the character of work done in the Rowan shops—heavy marine engines and boilers with very little repetition work—that is very likely true.

So far it has been my aim to present the subject, divested of all personal opinion, allowing each reader to draw his own inferences from the matter itself.

My own conclusions from the matter presented in this and the previous two chapters are that:—

1.—From the workman's point of view:

A.—Whenever time savings are possible, piece work, when guaranteed against cutting, is preferable, but

B.—Experience with piece work has shown the general great difficulty of keeping it free from rate cutting; taking into consideration also the penalizing effect of a lessening wage rate when time is lost,

C.—The premium systems, such as the Halsey 30 and 50-per cent. and the Rowan, in the order named, best conserve his interests; they have the merits of an increase in earnings for increased effort, without making this so great as to excite the danger of cutting, particularly as these systems are often coupled with a distinct guarantee against that, and also because they insure a minimum wage rate when time is lost.

2.—From the managing employer's point of view:

A.—Day pay would be the most desirable plan, as giving the greatest profit, provided the men could be stimulated to the necessary effort; but the difficulty is so great as, in most cases, to render the adoption of day pay inadvisable if large time savings are looked for.

B.—The piece plan provides the necessary stimulus for increased effort, but gives relatively low profit returns; it is also in general disfavor with workmen's organizations, and in case of error in the direction of too liberal a time allowance practically necessitates objectionable rate cutting; in view of this

C.—The premium plans are a compromise that result in profit re-

turns most nearly approaching those of the day-pay ideal; they are acceptable to the men and their unions, and avoid the necessity of rate change in case of too liberal a time allowance, since only a part of the wage value of the error appears as an element of cost. The 30 per cent. or other low-rate plan is best for skilled labor attending the machines, and a higher rate where greater muscular exertion is called for; for heavy machine work, not often repeated and demanding outlay for plant and tool improvements, the Rowan plan has claims to serious consideration.

3.—The interests of invested capital are also best served by the premium plans for the reasons just enumerated, and further because they result in:—

A.—The highest attainable interest return on the capital invested.

B.—They provide in the most acceptable way that stimulus necessary to bring about time saving which results in the more frequent turn-over of capital, or in its release for further employment in other lines.

4.—In an interest far more general than that of the individual employer or capitalist—that of the entire consuming and producing race of man—those methods of wage payment are best that combine the highest wage and interest returns for both workman and capital, while tying up the least amount of labor effort and capital; since, in that way they increase the producing power of both and make both freer to exert their beneficent influence in the production and distribution of more and more necessaries and luxuries in a never-ending chain.

EDITORIAL COMMENT

TO the transfer of the title to the Panama Canal Company's property, assuring our ownership beyond the shadow of chance of question, the events of the past month have added perhaps the most gratifying assurance of all in the appointment of Mr. John F. Wallace to the post of chief engineer. This assurance is that the work of making the canal will be carried out with the careful study, the sound decision, the full preparation, the energetic action, the executive direction, and the unswerving integrity which alone are adequate to so momentous a National undertaking. Mr. Wallace's record is witness to his unusual administrative capacity—his tact and ability in harmonizing and controlling the many elements necessary to the conduct of great enterprises. He is a sound engineer whose work has been notable in many lines that will meet in this great undertaking. With an exceptional range of experience he combines a sense of proportion and a balance of judgment invaluable in dealing with new problems. Under his initiative and control, we feel content that the work will be carried on upon a sound business basis. To its successful accomplishment we are confident Mr. Wallace not only will devote the uttermost of his own eminent ability, but will bring all other specialized knowledge, talent, or experience capable of contributing to the best execution of the vast project which the United States has undertaken in the interest of the world.

* * *

WITH the opening of the international exposition at St. Louis we may again call attention to a curious and almost inexplicable fact which re-appears continually in such displays. Millions are expended by governments and by individuals for the creation of magnificent buildings, and these are filled with expensive and comprehensive exhibits at further large cost, and then these exhibits are, in very many cases, either neglected or placed in the charge of wholly incompetent or indifferent individuals. It has been the experience of almost every interested critical or scientific visitor at any of the great expositions, from the Philadelphia Centennial down to the present time, that the things which he desires to see and to understand have been found either utterly neglected, or else in the charge of some one who, if he does not treat the visitor with absolute rudeness or discourtesy, is entirely indifferent and unapproachable. Who does not recall the insolent subordinate, tilted back in his chair, his feet up on his desk, with a smouldering cigar stump between his teeth; or, perhaps the surly individual in overalls, unable or unwilling to give attention to the very persons for whom the exhibits have been sent or installed. That there are exceptions to this unsatisfactory rule, we gladly admit, but speaking from an extended personal experience at many great expositions on both sides of the ocean, the writer cannot but affirm that, in the engineering departments especially, the neglect of proper attendance is most general.

There are various reasons for this state of affairs. In many cases the choice of the representative is made from altogether different reasons from those which would command efficiency. It is considered something of a pleasure trip by many firms, and the post is

given to some younger member of the family, or to some friend who wants to see the show at the firm's expense, while the really competent man is thought to be needed too much at the works or in the office to be spared for such a holiday. Holiday it should not be, but rather a most difficult and exacting task, demanding the highest degree of tact and experience, together with familiarity with the whole state of the art of which the exhibit forms a part. To send any inferior person is to waste in great measure the benefit to be gained by all the expense which has been incurred in sending the exhibit.

There is now time at St. Louis for a reform to be instituted in this matter, and it will be a subject of interested investigation, upon which we hope to comment later, to determine the extent to which exhibitors have learned by experience. To install an expensive and creditable exhibit, and then to hedge it about with bars and ropes and leave it to itself, or to place it in charge of an indifferent and incompetent person, who feels it his whole duty to acquire the insolence which comes from a brief investiture of power, will be to nullify in great part the value of the display ; while the presence of a courteous and intelligent attendant, who welcomes every caller as a personal friend of his firm, whose inquiries are to be met half-way and whose studies to be encouraged and aided, will render the St. Louis exhibition notable.

* * *

IN our issue for March last we reviewed at length the discussion upon the relation of the administration of the patent laws of the United States to the development of the mechanic arts, which took place at a meeting of the Technical Society of the Pacific Coast, and quoted the remarks of Mr. John Richards, himself one of the best-known engineers in the country, to the effect that the present conduct of the United States Patent Office "is an amazing example of routine work, done by rule, and apparently without personal discretion—by rules that have grown out of the conduct of the office and the circumstances of procedure."

Mr. Richards attributed the present low standard of patent-office work to the fact that the examiners are men of limited attainments, at moderate salaries, and without any especial interest in seeing that their work is judicially done, while opposed to them are large numbers of able, skilled lawyers and patent solicitors, actively engaged in pushing the interests of their clients. These views have attracted much attention, and their correctness seems to be fully confirmed by the fact that Mr. Edison has had to appeal to the President of the United States in order to secure even consideration for his statement that the contents of a recent application of his own were divulged to another applicant, who was allowed to withdraw his application and incorporate in it some of the features of Mr. Edison's invention.

In a subsequent newspaper interview, Mr. Edison is quoted as stating that the trouble lies largely with incompetent examiners. "They take a couple of young men out of the bottle department or the collar-button department and set them to work examining an application for a system of wireless telegraphy or some similar thing."

The young men are not to be blamed, of course, since it is their duty to try and do their best, however ignorant they may be, but what is to be thought of the Commissioner under whose administration such things can occur, or, who, being appealed to, permits the appeal to get past him to the President?

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

MARINE STEAM TURBINES.

STEAM TURBINE PROPULSION FOR GENERAL MARINE SERVICE AND HIGH-SPEED TRANSATLANTIC LINERS.

A. Rateau—Institution of Naval Architects.

ALTHOUGH the steam turbine was early applied to marine propulsion on a small scale, its subsequent development, until recently, has been in stationary service, doubtless because of its applicability for direct connection to dynamos operating at high rotative speeds. During the past few years, however, the development of the marine turbine has been rapid, and its successful applications to vessels of large size, both for river and channel service, have demonstrated the fact that it is well adapted for general seagoing vessels.

At the recent meeting of the Institution of Naval Architects a paper was presented by Professor Rateau, of Paris, upon the subject of steam propulsion for marine purposes, and about the same time the announcement was made that the directors of the Cunard Company had decided to adopt turbine propulsion for the new express steamers to be constructed for their line. We give some abstract and review of Professor Rateau's paper, and also some notes from an editorial in *Engineering* upon the action of the Cunard Company.

The paper of Professor Rateau is especially interesting from the fact that it discusses the performance of turbines upon a vessel identical in all other respects to some which have been equipped with reciprocating engines. The boat in question was a torpedo boat, built by Messrs. Yarrow, and was similar in all respects to thirty other boats of the same firm. The boat was also peculiar in being fitted with a small reciprocating engine, for reversing and for cruising at reduced speeds, this engine being connected to the central shaft, and the side shafts being driven by Rateau turbines; there being three shafts in all.

According to Professor Rateau, there are three principal difficulties encountered in the use of steam turbines for marine propulsion. These are the proper design and arrangement of the propellers for high rotative speeds; the low efficiency of the turbine at low speeds; and the provisions for reversing and manœuvring.

The first two difficulties arise from the fact that the best efficiency of the turbine is attained at high speeds, while the best action of the propellers is secured at lower rotative speeds. In some of the earlier turbine boats propellers of very small diameter were used, several being placed on each shaft, and this appears at present to be the most practicable solution of the question. Larger single propellers involve larger turbines, and this brings with it greater weight, thus causing one of the chief advantages of the turbine to be reduced. According to Professor Rateau, there is a lower limit of speed, below which the use of turbines cannot be recommended. This limit he places at about 20 knots, but since turbines are now being applied to transatlantic liners intended to be run at 17 knots, so that practical data of performance will be available upon this question.

Reports of trials made upon the Yarrow torpedo boat show that for a development of 2,000 horse power the steam consump-

tion was 13.4 pounds per effective horse-power-hour. which corresponds to 11.7 pounds per indicated horse power for a reciprocating engine having 12 per cent. loss due to internal friction. This is excellent economy, and when it is understood that the total weight of 2,000 horse power of turbines is only 17,200 pounds, or 8.6 pounds per horse power, the advantages are apparent. The reciprocating engine used for cruising and reversing in this case is of 250 horse power, this having been found ample for the purpose. The turbines may also be arranged for going astern, if required, although this is hardly considered necessary.

While this combination of reciprocating engine and turbines appears to be most practical and useful for naval purposes, where much cruising is done at low speeds, and where full power is required only for a small part of the time, it is hardly necessary for transatlantic liners, which are driven at full speed nearly all the time they are at sea. This was the problem presented to the commission which reported upon it to the Cunard Company, and doubtless the special conditions had an important bearing upon their conclusions. The commission, consisting as it did, of engineers familiar with all sides of the question, have furnished a report of more than passing importance.

"The Cunard Company started with the resolve that the two vessels to be built under the agreement with the Government for carrying the American mails and for service as mercantile cruisers in times of war should represent the highest possible attainment, alike in naval architecture and marine construction; and if the negotiations in connection with the design of the vessels have been more than usually protracted, full justification will be found in the many important innovations, making for reliability and success, likely to be introduced into their construction. In the first place, extensive model experiments were carried out to determine approximately the power necessary to attain the speed anticipated in the agreement with the Government, of from 24½ to 25 knots, with different dimensions and varying lines. It is understood that the result was that a length of 760 ft. was found to meet most of the requirements, but that the weights to be carried demanded a beam in excess of that hitherto found necessary for merchant ships, some of the models ranging up to 88 ft., so as to give a high prismatic coefficient of fineness to minimise the power necessary to give the speed."

Having determined the data for the hulls, the question of motive power was to be considered, and it was upon this point that the special commission reported. Tests were made upon the turbine steamers running between Dover and Calais, and between Newhaven and Dieppe, and also upon turbine engines in stationary service, and every attempt has been made to secure reliable data upon which to base conclusions. Discussing the subject editorially, *Engineering* says:

"The report, it is said, reviews the turbine from every standpoint, and is probably the most carefully-prepared judicial pronouncement on the subject yet made. When the turbine was first proposed, it was naturally anticipated that there would be a saving in weight per unit of power, and this became a most important matter in the case of a vessel that must develop something like 70,000 indicated horse-power to get a speed of 25 knots. But it is now understood that the Commission place the economy in weight at nearer 3 per cent. than the 10 per cent. at one time thought possible. On the question of fuel economy there has always been difficulty in arriving at definite data; but here the trials of the Midland Railway Company's new boats, which differ only in their propelling machinery, will yield valuable information. It has been stated that the trials of the Channel steamers showed an economy of 2 per cent. as compared with reciprocating machinery; but there is an accumulation of reliable data to show that in electric light stations a much greater saving is realised. In such marine installations as have been the subject of comparative trials there were other variants influencing the issue. At low power there is now no question that the turbine is not so economical. But this disadvantage operates more in the case of naval ships, where the greater part of the steaming is at low power; it does not affect the merchant ship—especially the Atlantic liner—which runs for 99 per cent. of her time at full power. The turbine machinery can therefore be easily designed to give the

highest efficiency at full power; and good results will thus be insured."

In some respects the points made by Professor Rateau have evidently appealed to the commission, especially that of abandoning the use of several propellers on each shaft.

"It is understood that four shafts will be fitted in the new ships, probably with one propeller and one go-ahead turbine on each. This is not the first installation of quadruple shafts to be carried out. Hitherto in British ships three shafts have been installed; but the first turbine-driven war vessel built for the German navy, the Lubeck, recently launched from the Vulcan Works at Stettin, has four shafts. In this case the decision was doubtless influenced by the question of economy at low power. When two of the shafts are run for low speeds, higher efficiency will be attained, because the two turbines will run faster than if three or four were in use for the same power: it is well known that steam loss increases as the revolving speed decreases. In the Cunard liners, however, the four shafts are almost a necessity, as is would be inadvisable to transmit the enormous power required through three shafts. While a sea speed of 24½ knots may be got with 65,000 horse-power, there must be something in reserve to ensure regularity in the hour of arrival. The adoption of the four shafts has the great advantage of increasing the duplication, so that there will be the minimum of delay consequent upon the fracture of a shaft or any breakdown of one of the four propelling units. There will likely be two distinct steam cycles, the two low-pressure turbines being placed on the two inside shafts, while the high-pressure turbines will be on the outside shafts. The two reversing turbines will also be placed on the inside shafts. The intention, we understand, is to minimise the revolutions of the propellers, as experience has shown that slow-running, large-surfaced, coarse-pitched propellers give the best results."

In view of the eminence of the members of the commission and the great care which they have evidently taken in their work, this report must be considered as one of the most important engineering documents of the time. The execution of the work in accordance with their recommendations will put their opinions to the test, and complete success will mean a revolution in transatlantic express service.

CONTINUOUS INDICATOR DIAGRAMS.

METHODS OF OBTAINING CONTINUOUS RECORDS OF THE ACTION IN ENGINE CYLINDERS BY USE OF THE ORDINARY STEAM INDICATOR.

W. Schüle—Verein Deutscher Ingenieure.

SINCE the original invention of the steam-engine indicator by Watt, nearly all the improvements have been made in the direction of greater accuracy and adaptability to modern conditions of speed and pressure. With but few exceptions the indicator has consisted of two elements: a pencil, shifting its position in accordance with the changes of pressure in the cylinder, and a recording surface moving in synchronism with the piston. Usually these movements occur in a cycle, so that if the instrument is applied continuously a succession of closed diagrams are superposed upon the same card. For many purposes this arrangement serves well, and there is no doubt that the great advances which have been made in steam engine design and performance have been largely due to the practical information gained by the use of the indicator since its improvement by Richards and his successors.

There are, however, a number of operations for which it is very desirable to have the successive cycles separated and arranged consecutively, so that their sequence may be studied as well as their separate characteristics. Thus, in the case of the gas engine, the action of successive strokes may be very different, especially if the hit-and-miss method of governing is employed, and any attempt to compute the power of an internal combustion motor without a comparison of a large number of consecutive diagrams, showing the actual number of power strokes and the accompanying action would be most misleading.

It is also desirable in some instances to

have the pressures recorded at uniform time intervals. The motion of an engine piston is necessarily variable, ranging from a maximum to zero twice every revolution. If this speed variation is accurately reproduced upon the indicator drum a correct diagram will be obtained, it is true, but such an arrangement gives the slowest motion at and near the ends of the stroke, crowding the record into a small space at the very point where it is most desirable that it should be open and easily read and studied.

A number of continuous indicators have been designed, one of the first of these being by Gooch, the eminent railway engineer in the early forties, and this instrument, with its stiff, elliptical spring, short stroke, and small moving parts was a noteworthy improvement on its predecessors. For simplicity, however, it was made to use curved pressure ordinates, so that its records were not directly comparable with other existing instruments, and it is now only a mechanical curiosity. Later continuously operating indicators have been designed, some of them very complete and complicated, but their cost and character have rendered them applicable in general only to the testing laboratory or the research bureau.

In a paper recently published in the *Zeitschrift des Vereines Deutscher Ingenieure* Herr W. Schüle describes a plan for obtaining "time" diagrams with a modification of the ordinary indicator, and the plan is also suggestive of a similar arrangement for taking continuous diagrams, when such are desired.

The idea of a diagram in which the pressures should be recorded at uniform time intervals includes the independence of the motion of the paper drum from that of the engine, a condition which is advantageous in many ways. It removes at once all difficulty in securing the accurate synchronism between drum and piston movements which is otherwise necessary; besides which it enables all irregularities in various parts of the action of the engine to be studied upon an absolute time basis. Such diagrams may readily be obtained by removing the drum spring and arranging the drum so that it may be given a continuous and uniform motion of revolution about its axis. This uniform rotary motion is provided in the apparatus of Herr Schüle by an ingenious application of the principle of the well-known Atwood's machine. The indicator, which may be of any one of the well-known modern types, is so placed that the drum is in a horizontal position, the drum spring having been removed and the drum being left free to revolve. A cord, with equal weights attached to the ends, may then be hung over the groove in the drum, and the motion started by placing a small auxiliary weight upon one of the two main weights. As soon as the resistances have been overcome the auxiliary weight is removed by a properly placed catch, and the velocity thus acquired is continued uniformly. At this moment the recording pencil is applied and its movements are traced upon the uniformly revolving drum. Several superposed diagrams are thus obtained, while by a slight modification the drum may be arranged to wind off a continuous strip and thus separate all the records, the successive strokes appearing as a continuous line.

Herr Schüle has made careful investigations and calibrations of the instrument used by him, in order to determine all the resistances which may affect the result, and this portion of his paper should be consulted by those who may attempt similar arrangements, since these resistances are different for every instrument. Careful tests show, however, that practical uniformity is obtainable with this simple apparatus, and its value will be readily apparent.

A number of diagrams taken with this form of indicator are given by Herr Schüle and the insight which they give into the action of the steam and the valve gear, especially near the ends of the stroke, is apparent. The change from compression to lead curves, too often skilfully concealed in the ordinary diagram, is clearly brought out, and the behaviour of the valve gear, even at its most rapid portions of travel, may be seen. By arranging instruments connected with both ends of the cylinder to make their records upon the same drum, the impelling and resisting forces may be studied as they really occur, and a clear idea of their action obtained.

Diagrams traced by the "time" indicator may readily be transformed into those of

the usual form by transferring a number of points, and Herr Schüle gives examples of such transformations, as well as a number of studies of diagrams from engines of well-known builders.

Although such continuously recording indicators may doubtless be prepared according to the plan suggested and employed in this valuable paper, it is most desirable that such instruments should be primarily constructed and calibrated especially for the purpose by competent instrument makers, in order that results obtained in various places by different observers may be strictly comparable. The great value of the continuous time diagram, both for the steam and the gas engine, is fully shown in the paper of Herr Schüle, and the method would doubtless come into extended use if standard instruments were readily obtainable at moderate cost. That such instruments can be made at no greater cost than the ordinary indicator is evident, and all that is needed is the undertaking of their commercial manufacture by competent hands.

THE ADAPTABILITY OF ELECTRICAL DRIVING.

A COMPARISON OF MECHANICAL AND ELECTRICAL TRANSMISSION AND SUBDIVISION OF POWER IN THE WORKSHOP.

B. Longbottom—Manchester Association of Engineers.

ALTHOUGH much has been written about the advantages of the electrical driving of machinery there is not an abundance of reliable information concerning the real difference between the old method of shafting and belting and the new one of line wires and motors, so far as actual efficiency is concerned. Much of the published matter is general in its character, and close comparisons are not readily attainable. For this reason the paper of Mr. Longbottom, presented before the Manchester Association of Engineers, and published in the *Electrician* is of value and interest.

In this paper there is an attempt to make a direct comparison between mechanical and electrical transmission, taking into account the practical working conditions. Certain assumptions must necessarily be made, but the principal data have been derived from actual tests, and the deductions appear to have been impartially made.

In the case of ordinary mechanical driving, employing shafting and belting, the principal point to be taken into account is the power required to drive the empty shafting, and its auxiliary attachments, countershafts, etc. Mr. Longbottom gives data of a number of tests to determine this point, choosing his data from plants ranging from 30 to 900 horse power, ranging from one-half to full load. The proportion of the total power absorbed by the transmission necessarily varied, being the greatest for the smaller installations, the power required for the transmission ranging from 25 to 75 per cent. of the whole. Mr. Longbottom, after weighing the conditions in each case, estimates that the average effective power delivered to the machines may safely be taken as 55 per cent. of the total indicated power of the engine.

In the case of electrical transmission the losses may be divided into several parts. Making allowance for the losses in the engine and generating plant, it is estimated that an efficiency of 82 per cent. can be reached at the engine-room switchboard. From thence the losses are divided between the distributing cables and the motors. The distribution losses in an ordinary shop are small, for full load the transmission losses are taken at 3½ per cent., of 2 per cent. at three-quarter load, this bringing the efficiency at the motors, to 80 per cent.

"We can reasonably assume the motor units in our example to be 5 B.H.P., and 10 B.H.P., and take 7½ B.H.P. as the average. Assuming again three-quarter load, which will imply an efficiency, say, of 83 per cent. as the mean efficiency of the motors, we have a total efficiency at the motor-pulleys of 83 per cent. × 80 per cent. = 66½ per cent., or 66½ B.H.P. In the case of the individual machine when driven direct, it is obvious that no further loss takes place, but when the machine is driven by gearing, chain or belt, there is a loss of 2½ to 5 per cent., and this must be deducted from the ef-

ficiency at the motor shaft. As far as engineering works are concerned, latter-day practice shows a decided tendency towards this method of driving, as the power required to drive small machine tools has been greatly increased by the advent of high-speed tool steels, and increased cutting speeds. However, in the majority of electrically-driven works, it can reasonably be assumed that from one-quarter to one-third of the power is taken up by group-driving We will take the latter to be the case, so, continuing with our example, we have two-thirds of the available power—say, two-thirds of 66 B.H.P. (44 B.H.P.)—reduced a further 3½ per cent.—*i. e.*, 1.55 B.H.P.

Tests which have been taken at hazard, show that the frictional losses in well arranged group-driving should vary from 10 to 25 per cent.

For the remaining 22 B.H.P. we will then assume a liberal frictional loss of 20 per cent., which amounts to 4.4 B.H.P. This gives a total loss of, say 6 B.H.P., which must be further deducted from the 66 B.H.P. at the motor shaft, leaving us with an efficiency of 60 per cent. for electrical distribution as against 55 per cent., which was taken as the fair average for mechanical distribution."

Comparisons made at lighter loads show somewhat more favorably for the electrical transmission, since the transmission losses are proportionally larger for the mechanical system at partial loads, while this is not the case with electrical driving.

So far as the much discussed question of independent or group driving is concerned, Mr. Longbottom has some interesting remarks.

"In the past there has been a great diversity of opinion as to whether each machine should be driven by a motor, or a number of smaller machines should be grouped together and driven from a short line shaft by one motor, but it is now generally recognised that where machines are in constant use, provided they are below a given horse-power—say 5 H.P.—grouping is the most desirable. This method most successfully overcomes the great variation of power that is experienced in the driving of small machines, due to the difference in the load, and the cycle of operations, and is naturally more efficient than if a number of smaller motors were employed on account of the necessarily lower efficiency, as well as more economical in first cost and upkeep. Moreover than this, the aggregate of the horse-power of the single motors would be much higher than the horse-power of the one motor driving the group of machines, as each of the smaller motors must be large enough to deal with the maximum load of its machine, whereas only a slight addition is required to the average working load in the case of the group motor, sufficient to be capable of dealing with the heaviest loads of a certain percentage of the machines in question."

In order to secure the best results from group driving care must be taken that too many machines are not driven from one motor, or that they are not spread over too great an area, since it is possible in this manner to introduce losses which would exceed those due to the old method of mechanical driving. Judgment should be exercised in the choice of a proper system of motor units, the machines being subdivided into the most efficient groups to suit the units. In the average engineering works the smallest unit may be taken as 5 horse power, while other useful units are 7½, 10, and 15 horse power; larger units are only required for individual driving of heavy machinery.

"In these days of specialisation, it is of the greatest importance that machinery and departments should be arranged with a view to economical and increased output, and it is now possible for the works organiser to achieve this result without taking into account how the power has to be delivered to the machines. It is no longer necessary to arrange the machinery in parallel lines down the works, so that it can be driven from line shafts supported from the main girders, as is the case with the best arranged mechanical distributions; but under the same roof he can have as many sections or departments as he wishes, each entirely self-contained.

"It is quite probable that in attaining this result some sections will not be driven as efficiently as may have been possible, but provided the production is increased by the arrangement with the same outlay in labour, it justifies itself. The saving of power in such an instance is of secondary considera-

tion. Now that there is no longer the weight and strain of heavy shafting on the girders to contend with, lighter structures can be used, resulting in a material reduction in the cost of the building, thus further defraying the cost of the electrical plant.

"Then the advent of portable machine tools and other labour-saving devices has been rendered more possible by the electric motor, and the economies to be obtained by these methods of manufacture are daily becoming more apparent.

"Again, in new works there is always a danger with mechanical distribution of the power plant becoming too small as the business increases, with disastrous results as far as further development is concerned; but an electrical system is perfectly elastic, it being only necessary to put down another generating unit and an additional panel on the main switchboard, and this can be done without in any way affecting the efficiency of the existing plant.

"It is now possible for the smallest user to obtain electricity for power purposes at a price varying from 1d. to 2d. per unit from our corporation and supply companies, and this must be of vital importance to young firms who require their available capital for other useful purposes, especially when they have the knowledge that their power costs them comparatively little more than would have been the case if they had had a plant of their own."

These investigations of Mr. Longbottom only serve to confirm what has been accepted as the result of general practical experience; that is, that the actual saving in the mere transmission of power by the electrical over the mechanical system is hardly great enough in itself to warrant the change. The small saving in power is undoubtedly effected, but the power element in the cost of manufacturing forms such a small portion of the total cost of the finished product that the gain in reducing it by a small percentage is almost immaterial. The great advantages of electric driving are altogether due to other elements than those of transmission. It is in the saving of the valuable room, in the ability to place machines according to their most efficient use, regardless of the location of the engine or shafting, and in the general improvement in operation of the whole plant that the great advantages lie. Even if the transmission losses were greater with electric driving it would be a gain in many cases to make the change, and since it has been shown that there is no loss, the added advantages are a clear advance in the operative element of works management.

RECIPROCATING STEAM ENGINES.

THE HIGH ECONOMICAL PERFORMANCE OF MODERN RECIPROCATING STEAM ENGINES IN COMPARISON WITH THE STEAM TURBINE.

J. A. Seymour—Electrical World and Engineer.

IT has rather become the fashion of late to assume that all the virtues as a prime mover belong to the steam turbine, and that any engine so hopelessly old-fashioned as to be constructed with a piston reciprocating in a cylinder is not to be considered. For this reason the article by Mr. J. A. Seymour, in a recent issue of the *Electrical World and Engineer* is timely and interesting, and the case, as he presents it, shows that the old friend which has done such good work in the past is not altogether out of the running.

It must be admitted that the steam turbine represents the latest and best work of a number of able engineers and investigators, and that its present state of development has followed numerous series of exhaustive experimental studies. Under such circumstances it is only right that any comparisons which are made should be with reciprocating engines of the latest and highest type, and conclusively based upon the performances of older machines laid aside as misleading.

As a practical engine builder Mr. Seymour naturally refers to the performance of engines made by his firm, but the tests upon which his argument is based have been independently made, and undoubtedly represent accurately and impartially the performance of modern high class reciprocating engines of the best makers. These tests are compared with trials of a Westinghouse-

Parsons steam turbine made by Mr. Mattice, whose name is sufficient warrant for their trustworthy character, and the conditions of the two sets of observations were close enough to permit comparable conclusions to be drawn.

In the first place Mr. Seymour very correctly remarks that the performance at light or partial loads should be considered, since proper provision for overload demands cause the average working load to be less than the full rated power.

"Whatever advantages in actual commercial use the steam turbine may ultimately prove to possess, there are no indications at the present time that among these advantages will be a better sustained economy at light loads than with the reciprocating engine. It is true that "the usual" or "average" rate of steam consumption of reciprocating engines at light loads is excessive, as compared with the full-load economy, but the usual or average reciprocating engine is really an uneconomical and out-of-date machine. The ideal reciprocating engine working with non-conducting cylinder walls, without loss from leakage, cylinder condensation or radiation, should expand to back pressure to secure greatest economy. To expand to back pressure in an actual engine would load it much below its most economical point. It follows that since a modern engine of economical type, having a much lower rate of steam consumption at full load, approaches more nearly the ideal engine than the above-mentioned average engine, it should effect proportionately a still greater saving at light loads; that is, it should have a flatter economy curve. In actual practice this is found to be true."

The results of the tests are given in the form of curves, and from these it distinctly appears that the best performance of the turbine is attained at or about full load, the curves showing a continually increasing rise as the loading is reduced. The reciprocating engine, on the contrary, attains its maximum economy at about 0.8 of the full load, while the flatness of the curve on either side of this point shows that the performance varies but slightly between 0.7 to 0.9 of the full load. In the particular instances under consideration the steam consumption per electrical horse power hour at 0.8 of full load was about 12½ pounds for the reciprocating engine and about 14 pounds for the turbine; the turbine steam consumption fell to about 13½ pounds at full load while that of the reciprocating engine rose to about 12¾ pounds. The reciprocating engine was a vertical cross compound, with cylinder ratios of 4 to 1, with steam jackets and interheater, and the steam from the jackets and reheater were charged against the consumption. Both machines were operated with superheated steam, and both discharged into vacuum; the superheating being about 80° F., and the vacuum averaging 27.5 in. for the turbine and 25.6 for the reciprocating engine.

Commenting on the correctness of the view that performance at average light loads should be taken into account, for electric stations, at least, Mr. Seymour says:

"Central station managers will hardly consider it practical to run steam turbines at their most economical loads without a greater overload capacity than it is proposed to give them, where the station load is a fluctuating one. At times of maximum station load it quite often happens that the steam pressure and vacuum fall off and the loss of pressure in the pipes, etc., increases so that the actual maximum output of the unit under these conditions may fall short of the nominal overload capacity under normal conditions to a very serious extent. In the case of a turbine a very high vacuum is necessary in order to maintain either its capacity or its economy. To secure this high vacuum, particularly under heavy overloads and in warm weather, with condensing apparatus of a commercially practicable size, in most locations, will be an extremely difficult problem, a much more difficult problem than is generally understood, but one which will have to be met."

While admitting the full force of Mr. Seymour's argument for the superior efficiency of the reciprocating engine in its best types over the steam turbine, it is really a matter for encouragement that the latter machine has done as well as it has. It is now rapidly approaching the 150th anniversary of the first patent of Watt, during which time the reciprocating engine has been the subject of the concentrated efforts of the ablest engineers over the entire world. The turbine in its practical form is only about 25 years old, and its possibilities

have been realized only during the past decade, and in that brief period it has leaped past the reciprocating engine as it was when the competition began, and is admittedly excelled only by the latest improved types.

While the efforts of engineers to improve the performance of both types may well go on, it must be realized that steam economy is but one of the factors in the economy of power generation. It is not economy of steam which is the final criterion, but economy of money, and there are other elements which go to make up the final result. If the turbine enables economies in first cost, in foundations, in space, smoothness of running, and operative elements to be obtained, it may prove the cheaper source of power, even if it does use a little more steam; it is to the final cost of the power that we must look in making the comparison.

THE DIRECT OBSERVATION OF STRESSES.

VISIBILITY OF INTERNAL STRESSES IN TRANSPARENT BODIES BY THE USE OF POLARIZED LIGHT.

Zeitschrift des Oesterr. Ingenieur und Architekten Vereines.

THE study of the effect of external forces in the production of internal fibre stresses in structural work is one of the most important departments of the work of the engineer, and it has received much attention from many able investigators. Various methods have been employed, but the tendency of late has been to supplement the analytical methods of the mathematician by graphical diagrams and similar ocular demonstrations. These may be lacking in precision compared with the more elaborate methods of computation, but the general insight which they give into the various problems involved gives them a distinct advantage. In many instances the degree of precision thus obtained is quite within the limits of knowledge of the strength of the materials employed, and in any case the employment of two distinct methods of investigation furnishes a check upon errors of computation. A further extension of what may be called the ocular method of investigation is found in the examination of beams and other structural forms of glass of transparent material, using polarized light to enable the distribution and relative magnitude of the internal stresses to be seen and even photographed. Such a method is not entirely new, but it has been greatly extended of late, and in a paper presented before the *Oesterreichische Ingenieur und Architekten Verein* by Herr Otto Hönigsberg, and published in the Zeitschrift of the society, a very complete account is given of some recent investigations in which this method is employed.

In the consideration of the strength of structural shapes there are two elements about which it is desirable that correct information should be obtained. These are the lines of maximum stress, or what may be termed the paths which are followed by the forces between the points of application; and the so-called neutral lines or surfaces, where, owing to the reversal of the direction of the action of forces, the material is free from actual stress.

If the positions of these lines and surfaces can be accurately, or even approximately determined, the general distribution of material in the most efficient manner is made possible, and the whole subject cleared up for further research. In determining the position of the lines of force and the neutral axes and surfaces by computation it is necessary to know a number of things about the material under consideration, and any errors in the assumption of elasticity or homogeneity may affect the result in a marked degree. If, however, it is possible to render the position of these important portions visible, the correctness of the theoretical examination may be verified and the reliability of the more precise computations accepted.

Herr Hönigsberg considers the investigations of Culmann, giving examples of the lines of force as constructed by him for a beam secured at one end and loaded on the other, and also for a curved crane boom, and incidentally compares the lines in the latter structure with those visible in the human thigh bone of similar shape, and proceeds to discuss the accepted methods of determining these lines in metallic structures. He then

takes up the subject of polarized light, showing how, by the use of Nicol prisms for polarizing and analyzing the light transmitted through transparent substances any internal stress is made visible by the production of dark and light areas. By shifting the points of application and support the changes in the positions of the light and dark areas in the field of the polariscope are seen to indicate the positions of maximum and minimum stress, so that the distribution of the internal forces may be studied visually in a very interesting and instructive manner.

Applying this method to the examination of beams supported in various manners and with different applications of load, some very interesting information as to the location of neutral and stress lines is obtained, these being shown very fully in the photographs with which the paper of Herr Hönigsberg is illustrated. Although a clear idea of the results can be obtained only by an examination of the photographs, some of the general conclusions may be given.

According to theory there should be, in a beam subject to a bending, a neutral surface within which no stress exists. If this is correct there should appear under the polarizer a corresponding portion which remains dark for all positions of the rotated analyzer. This, however, is true only when the bending is unaccompanied by thrust, a condition which can readily be realized in the experiments and in the investigations of Herr Hönigsberg. The truth of the theory is clearly demonstrated. In nearly all practical cases, however, the forces act both to produce bending and thrust, and the examination by the polariscope shows that the position of the neutral surface is not fixed in such cases, but varies under various conditions.

A series of experimental investigations have been made upon two groups of bodies; these including curved shapes of various kinds, and bodies in which Hooke's law of proportionality of strain to stress does not obtain. Among these may be noted the photographs showing the distribution of stresses in rings subjected to external compression, crank shafts, car coupler hooks, and other shapes. The method may also be employed to show the localization of stress in the case of nicked test bars, and in many other interesting problems.

The location of the lines of maximum stress in beams and other shapes may lead to some interesting developments in connection with the development of reinforced concrete construction, since it will indicate clearly the best disposition of the reinforcing material. It is interesting to note that in some of his earliest work Monier placed the metallic reinforcements nearly in the lines of the actual stresses, although it does not appear that he was led to do this by any experimental investigations.

The researches of Herr Hönigsberg give a most valuable indication of lines along which much fuller investigations should be conducted, and the question is one which should commend itself to the directors of mechanical and physical laboratories as leading to important practical results.

ALCOHOL AS A MOTIVE POWER.

IMPORTANCE OF PERMITTING THE UTILIZATION OF ALCOHOL AS A FUEL AND ILLUMINANT BY THE REMOVAL OF ONEROUS TAXATION.

W. R. Ormandy—Automobile Club.

THE agitation for the removal of the present excessive taxation upon alcohol continues both in England and in America, and although no immediate results have as yet appeared there is every reason for continuing the effort to advance this important industrial and technical matter. The article by M. Dupays, in a recent issue of this magazine, has attracted much attention, and we now note a paper presented by Dr. W. R. Ormandy before the Automobile Club, showing very clearly the advantages which would follow the extended use of alcohol, especially as a fuel for motor vehicles.

There are two reasons why alcohol has not been seriously considered as a source of motive power until recently. One of these is the high price, a matter due almost wholly to prohibitory taxation; the other, its comparatively low calorific power, a property which has been misinterpreted to mean a low efficiency. Leaving aside the question of

the artificial increase in cost, due to excessive taxation, the matter of the calorific power may first be examined. Recent experience with gas engines has resulted in demonstrating that the efficiency of internal-combustion motors is by no means dependent upon the richness of the fuel. Lean gases, such as the waste gas from blast furnaces, having a calorific value of only 100 to 120 B. T. U. per cubic foot will give as high, or even gines, as can be obtained from the richer illuminating or natural gases. As a matter of fact the real measure is that of the thermal value of the mixture in the cylinder, and this will be found to vary but little in any case, owing to the necessity for admitting more air for the richer gases. Speaking upon this point Dr. Ormandy says:

"If the question be asked why alcohol was so long neglected as a source of power for internal combustion engines when efforts were being made in every direction to find an outlet for the over-production which was taking place, the answer is to be found in a consideration of the relative heats of combustion of this substance compared with those against which it had to compete. It is near enough for our purpose to take the heat of combustion of alcohol at 5500, and of petrol and paraffin at about 10,250. At first sight it would appear hopeless to compare two such substances as a source of power unless the price of the one possessing lower calorific effect was approximately one-half that of the other. If the value of a fuel were indeed measured by its heat of combustion, this would be the case; but fortunately it is not so. We depend rather on the number of calories which can be converted into work. In this respect it is interesting to follow the gradual development of German alcohol gas engine production. The solitary specimen above referred to showed at a brake test such a consumption that the efficiency was approximately 12½ per cent.—that is to say, 12½ per cent. only of the heat units conveyed into the machine were given out again in the form of work. If we compare with this the results of the comparative tests of the alcohol-driven gas engines entered in 1902, in the competition for the prize offered in that year by the German Agricultural Society, we learn what astounding progress has been made. Out of the ten machines entered in this competition no less than three gave efficiencies of from 32.7 to 30.9 per cent. when working on full load. This is an astonishing result, and it places the alcohol motor very high in the list as an economical machine for the conversion of heat into work."

The fact that a high degree of compression produces a high efficiency of operation in engines working on the Beau de Rochas cycle is well known, but when the mixed charge of air and fuel is compressed to a high degree there is danger of pre-ignition, due to the heat generated by the compression. It has been found impracticable to compress rich gaseous mixtures to the most economical point, owing to the low ignition temperature, and hence the use of high compression has been permissible only with the lean charges. In the case of alcohol there are two reasons for the practicability of high compressions. The high specific heat of alcohol vapor, and the fact that the spirit contains about 10 per cent. of water.

"The conversion of alcohol into a state fit for explosion requires other means than in the case of petrol. This is obvious, when we consider that the heat required for the evaporation of alcohol is about two and a-half times as great as that for petrol, and we have further to bear in mind that there is 10 per cent, of water present, requiring five and a-half times the amount of heat to evaporate it compared with an equal weight of petrol. At first sight it would seem that this would be a serious difficulty in the utilisation of alcohol, but if we calculate the actual amount of heat which is necessary to evaporate a certain quantity of alcohol containing 10 per cent. of water, we find that it amounts to only 5½ per cent. of the total heat of combustion of that same amount of alcohol—in calculating the heats of combustions, in all cases it must be understood that the heat which would be given out by the water vapour in the products of combustion condensing from the form of steam is not taken into consideration. This 5½ per cent. of heat necessary to convert the alcohol into vapour can readily be abstracted either from the exhaust gases of the motor or from the water taking away the heat from the cylinder walls."

An important feature in the use of alcohol is that it is much less volatile than petrol, and has a higher ignition temperature, so

that it is far less likely to be a source of accidental fires. Its storage need not be subject to the same stringent regulations, and less severe restrictions may be permitted for its carriage. The fact that it maintains a constant boiling point is important, since this permits the carburetter to be adjusted once for all, a matter which is impossible for the heterogeneous material known under the general name of petrol.

To the practical automobilist, after the advantages of alcohol as a fuel have been demonstrated, the next question is that of operative cost.

"From what has gone before we know that petrol and alcohol stand in the ratio of 2:1 as regards their heat of combustion, but that in the case of alcohol 30 per cent. of this heat is obtainable in the form of work, while in the case of petrol only 20 per cent. can be so obtained.

"We require, then, four parts of alcohol or three parts of petrol by weight to yield the same amount of heat in the form of work. Taking petrol at 1s. 3d. per gallon—price quoted the writer in Hamburg for quantities of 30 gallons—and allowing for the different specific gravities, we should have to buy alcohol at 1s. ½d. per gallon to place them on an equal footing as yielders of power.

"The comparison between paraffin oil and alcohol, taking their relative efficiencies at 15 per cent. and 30 per cent., shows us that these two would have to be sold at the same price to give equal economic results. From now up to the end of 1908 motor alcohol containing 10 vol. per cent. of water is to be had in Germany, delivered at the nearest railway station, at 9d. per gallon, in lots of not less than 1500 gallons, and 10d. per gallon in lots of 40 gallons, cask free, but returnable. To buy in quantities such as a pint at retail dealers it costs at the rate of 1s. 3d. per gallon, at which price it is still cheaper than petrol at 1s. 6d.—by no means an unusual price in England.

"The problem of supplying motor fuel at a price which will not only render it cheaper than petrol, but which will enable it to compete with paraffin oil, has been solved in Germany.

"What are the conditions in England? Buying methylated spirit in quantity, we can obtain it at 1s. 11d. per gallon, and when obtained it is not so suitable as a fuel either for motors or lamps as is the cheaper German spirit."

Dr. Ormandy makes such a strong plea for the revision of the question of taxation, based on the results in Germany, that his own words may well be given:

"Time is too limited for me to go at length into the question of German as compared with English law in regard to alcohol, either as to production, distribution, or use. This in itself is more than subject for a lecture, but I may inform you that although the German Government showed forethought for the chemical industries, they had taken little action as regards legislature concerning alcohol for other technical purposes—heat, light, or power—up to the year 1887. At that time commercial alcohol generally cost, retail, at the rate of 3s. 6d. to 4s. per gallon. Since then note the change! There is scarcely a village in the whole land where alcohol of guaranteed strength 90-95 per cent. cannot be obtained retail at 1s. 3d. to 1s. 4½d. per gallon. At this price it can be bought in stoppered bottles just as we are accustomed to buy mineral waters.

"Although I cannot deal at length with those phases of the German law which have called forth such a notable change, I can, by means of a few statistics, make evident the enormous importance and size of the traffic in technical alcohol has attained, and in some ways compare our own position therewith. In the year 1900-1 Germany produced 406 million litres—about 4½ litres = one gallon. Of this 112 million litres were used for technical purposes. In the same year England's consumption of technical alcohol was 13 million litres. Please note that this total quantity of 13 million litres is a little over half the amount used by the German chemical industries, and about two-thirds of the quantity used in the manufacture of vinegar per annum."

Regarded from an economic viewpoint, the subject is of immense importance, involving, as it does, extended agricultural as well as manufacturing interests.

"In conclusion, I say that the case for a reduction in the price of alcohol for technical purposes is well established. Cheap spirit would place the rapidly-growing motor industry on a secure basis, because the production of alcohol can be extended almost

without limit; it would give our chemical manufacturers a chance of gaining some share of the enormous trade now in other hands. Its production might be made, by suitable legislation, to encourage agriculture, to take back to the land some of the 900,000 workers who have left it since 1851, and give us back that physique in our young men, the loss of which is so bemoaned by the members of the National Service League and so worrying to the War-office. It might go far to settle that tremendously important problem of "Our food reserve in time of war." The enormous nutritive value of the potato crop —two and a-half to four times as great as that of a similar area under wheat—in an area necessary to produce, say, alcohol equal as an illuminant to one-half of the amount of petroleum imported yearly, would be of incalculable worth if we were ever in such position that immediate food was more important that prospective light. To be of real value a food reserve must be in this country, and if it is already spread over a large area of the country, so much the better. Give us only a portion of the vast sum which national granaries would cost, and we will improve the state of our agricultural industry, give the form labourer a chance to increase his pittance by winter work—alcohol and starch and dextrin making; encourage new industries and establish old ones firmly, and at the same time provide in a durable form our food reserve."

PRACTICAL AUTOMOBILISM.

QUESTIONS OF CONSTRUCTION AND OPERATION OF MOTOR VEHICLES FOR OTHER THAN PLEASURE PURPOSES.

M. C. Krarup—Iron Age.

THE development of the mechanically-propelled vehicle has taken a trend which is to many a disappointing one, and there is little doubt that the real progress which was expected a few years ago has not been realized. Instead of replacing the horse for purposes of industry and transport, involving great and permanent improvements in he practice of road construction and maintenance, the automobile has mainly proved to be a costly pleasure vehicle, built principally for displays of speed and show, and adding but little to the services in which it was most needed.

An excellent discussion of the present status of automobilism from this point of view is given in a paper by Mr. M. C. Krarup in a recent issue of the *Iron Age*, and the importance of the points brought out leads us to give some abstract of the article in this place.

"It was originally thought and intended that automobiles should take the place of horses in solving the world's short haul transportation problems. They have done nothing of the kind as yet. It was also thought that their main advantages would be their economy and reliability. This hope, too, has so far been disappointed. The automobile, as it has been developed, no more takes the place of horses and horse drawn vehicles than bicycling takes the place of walking.

"A craze for speed, when that quality was discovered to be easily within reach and to hold a charm of its own, overtook the automobile movement (at the Bordeaux-Paris race in 1895), and gradually changed all the original intentions of its leaders; as a mere temporary digression from worthier objects, it was thought, but the movement lost its bearings then and there and has never found them since. It is astray in fads and fancies, as everybody knows, and only a breach with some of its ten-year old traditions and "data" can bring it back to safe ground. This everybody does not know; in fact, it is roundly denied by many. The best men in the movement are, however, perfectly well aware that sooner or later there must be ten automobiles that pay for their going in dollars and cents for one that pays in pleasure, but they vaguely hope that the pleasure cars will show the way and furnish the capital for all necessary new departures. To what degree they are justified in this belief should appear from the following, especially from that in this article which relates to mechanics and designs.

"So long as the automobile movement had an uphill fight against prejudice there

was reason for dealing gently with its shortcomings and charitably with its misrepresentations, the latter being frequently only the delusions of unscientific builders. Only the rich bought machines, and they did not care how much the sport cost them. In fact, the cost was an attraction, because it promised the exclusiveness which had entirely vanished from the bicycle.

"But the promise that the automobile would speedily be developed into a popular utility—on the strength of which promise indulgence was asked, and granted, for the vagaries of the sport—has been redeemed in only the most stinted measure. The automobile, while highly and expensively developed as an instrument of pleasure, does not rise to the level of a true utility—superior to previous means employed—except in those branches of work only in which sustained speed is a fancied or real requirement and economy a subordinate consideration. For the rounds of physicians and inspectors, for ambulance calls, for newspaper delivery the automobile meets certain demands, but the moment the foot rule of commercial economy is applied in earnest its ability to compete with the horse cannot be conclusively demonstrated, as proved by the relatively small number of merchants who have adopted it for light delivery work. When it is operated above horse speed and horse hours, the expense shoots upward through 100 channels; when not so operated its advantage is doubtful. Speed invariably means repairs, accidents and high tire bills."

It has been maintained that the demand for pleasure vehicles would lead to an effort for improvement which would advance the entire work of automobile construction, and that industrial vehicles would profit by the expenditures of wealthy amateurs who encouraged the improvement of the expensive racing and touring cars. This is an old story and it has been heard many times in connection with the time-worn argument that horse racing should be encouraged in order that the breed of horses might be improved. One plea is about as useless as the other, and the experience with the racing automobile is of about as little value for the development of the commercial vehicle as is the breeding of the race horse for the improvement of the hackney. At the present time the automobile business bears a close resemblance to the former bicycle trade, encouraged by exhibitions, races, changing models, and all the tricks so well known to the public, and these are beginning to be appreciated at their true value.

Mr. Krarup calls attention to some neglected points in construction which should be considered before real improvement can be expected. First among these he places the tires.

"Probably the greatest misfortune to automobilism as the basis for a new industry was the existence of the air inflated rubber and canvas tire when the automobile was still in its infancy. The air tire had given good service under the light loads of the bicycle. Its adaptation to the motor vehicle forced the evolution of the high speed car, which should have come last, nipped investigation of other forms of spring suspension in the bud, reduced the dimensions of wheels, created the dust nuisance, and still presents unsolved problems. A degree of inflation sufficient to protect the rubber and canvas casing against deformation under the traction resistance (and the rapid destruction resulting therefrom) causes light cars to bounce and gives them small advantage of the spring effect. Under heavy cars, on the other hand, impacts against the casings are too severe for their material, whatever the air pressure, especially at high speed, and in default of better means for obviating early destruction the walls of the casing are usually so thickened with numerous layers of canvas that much of the elasticity is lost, especially that localized yielding to small obstacles which constitutes the air tire's main advantage over metal springs. They do protect wheels against lateral jolts, however, but this virtue is of great value only when high speed is a requirement, as lateral jolts amount to very little under other circumstances."

If as much effort had been directed toward the finding of an acceptable elastic support of greater durability as has been given to the construction of pneumatic tires there is little doubt that success would have been attained.

One of the most important features about automobile development is the production of some other fuel than gasoline. There is no reason why ordinary commercial kero-

sene should not be used, and in a motor of the Diesel type it would undoubtedly prove entirely satisfactory. The experiments which have been made in Europe with alcohol fuel have demonstrated its entire fitness for a fuel for internal-combustion motors, and with the development of the modern process of making a cheap ethyl alcohol from sawdust this part of the problem appears to have been solved. The removal of the internal revenue tax from denaturized alcohol should be demanded by the technical and engineering world in such a manner as to brook no refusal, since it is by such means alone that the motor vehicle can be supplied with a fuel which is open to all to produce, independently of the monopoly which controls the supply of petroleum products.

Improved systems of cooling, or lubrication, of shielding and protecting the machinery are demanded and must be supplied for commercial automobiles, and these will not be obtained until competent engineers are encouraged to devote their efforts to some more practical type of vehicle than the present high-speed pleasure and racing automobile.

BALANCED COMPOUND LOCOMOTIVES.

THE DEVELOPMENT OF THE DE GLEHN FOUR-CYLINDER COMPOUND LOCOMOTIVE IN THE UNITED STATES.

Engineering News.

IN the application of the compound principle to locomotive engines almost every possible variation of cylinder arrangement has been tried. The early engines of Mallet and Von Borries used but two cylinders, the high-pressure cylinder on one side delivering steam to the low-pressure on the other, and a special valve being used to enable both to receive high-pressure steam at starting. The compound engines designed by Webb for the London and Northwestern Railway were built with two high-pressure cylinders outside and one low-pressure cylinder inside, there being no parallel rods, and the cylinders connected to different axles. In the United States the Baldwin Locomotive Works has built many engines from the designs of Mr. Vauclain, these having all the cylinders outside, the high and low-pressure cylinders being connected to one crosshead. Various arrangements of tandem cylinders have also been employed, and nearly every designer has introduced modifications of his own in details of valve gear, connections, etc.

The present tendency of all these types to crystallize into the four-cylinder balanced arrangement, with inside and outside cylinder and separate crank connection is discussed at length in a recent issue of *Engineering News*, from which we make an abstract.

The original idea of compounding in locomotives was steam economy. This in turn gave place to the effort to get increased power from the constructive limits of boiler capacity. At present there is a third element to be considered, the possibility of complete balancing of reciprocating parts and the consequent elimination of the injurious hammer blows developed at high speeds with unbalanced engines.

"The feature of the four-cylinder balanced compound, which distinguishes it from other types of four-cylinder compounds, is that each of the four cylinders has its own cross-head, connecting rod and crank. Two of the cylinders are placed inside and drive a crank axle. In some designs, all the cylinders drive one axle, while in other designs the high-pressure cylinders drive another. With the four cylinders, and with cranks placed at suitable angles, there is a more uniform turning movement. The special advantage, however, lies in the fact that the weights of the reciprocating parts of one pair of cylinders may be made to balance those of the other pair, thus eliminating the necessity of using counterweights in the driving wheels to balance these reciprocating weights. Only the revolving weights remain to be balanced, and this is a comparatively simple matter.

"In the ordinary locomotive, as is well known, the reciprocating weights are partially balanced by the addition of metal counterweights in the wheels, but all the weight thus added is wholly unbalanced so

far as its vertical motion is concerned, and produces a so-called "hammer blow" upon the rail. If the reciprocating parts were wholly unbalanced, there would be a fore and aft vibration and "nosing" which would make the locomotive uncomfortable to ride on and unsafe. If the reciprocating parts were fully balanced by counterweights in the driving wheels, this whole weight would produce an additional stress on the rail at every revolution equal to its centrifugal force, and the locomotive would "roll" badly on its springs. In practice the locomotive designer has to steer between these two extremes and make a machine unbalanced both vertically and horizontally.

"With the small locomotives and moderate speeds which were the rule in the early days of railroading, the matter of balancing was comparatively unimportant. With the heavy high speed engines of the present day, having reciprocating parts weighing perhaps over 700 lbs. on each side, the problem of satisfactory counterbalancing is very serious indeed.

The practical development of the four-cylinder balanced compound locomotive is due to M. de Glehn, who, in conjunction with M. du Bousquet, the superintendent of motive power of the Northern Railway of France, designed and built a number of powerful engines on this plan, in 1895 and subsequently, about 1,500 of these locomotives now being in service.

"The essential features of the design are as follows: (1) The high-pressure cylinders drive one axle and the low-pressure cylinders drive another, the coupling rods between these wheels serving mainly to maintain the proper relative positions of the crank pins. (2) For each cylinder there is a valve and valve gear, with the usual reversing shaft, the two shafts being worked together or separately from the screw reversing gear, so that the lead of the two sets of cylinders can be varied at will. (3) The engine can be converted into a four-cylinder simple engine by admitting steam into the low-pressure cylinders, while at the same time a valve opens the high-pressure exhaust to the main exhaust. The advantages claimed are particularly in the division of stresses and the balancing of the reciprocating weigths, leaving only the revolving weights to be balanced by counterweights placed in the driving wheels."

The principal objections which have been urged against the four-cylinder balanced compound engine are the use of the inside cranked axle, and the complication due to multiplication of parts. In reply to these it is maintained that the cranked axle has been in practical use for many years in England and no difficulty has been found in actual service. The improvements in materials and methods of working should render it possible to use such axles with entire safety, especially with compound engines in which the stresses are distributed and hammer-blow shocks eliminated. So far as complication is concerned, there is no objection to it if corresponding advantages are gained, and the experience in France has proved that smoothness of running and freedom from delays has followed the use of the new engines.

In the United States engines of the De Glehn type with some modifications are built by the Baldwin Locomotive Works, and there is every reason to believe that this design will become popular to the elimination of the earlier Vauclain arrangement. A powerful locomotive for the Atchison, Topeka, and Santa Fé Railroad is illustrated in the issue of *Engineering News* referred to, this being a modification of the De Glehn and the Von Borries type by Mr. Vauclain.

"It is certain that as far as European practice is concerned the four-cylinder balanced compound has established its practical efficiency in the test of extensive regular service, both in regard to the number of engines and the length of time they have been in service. In this country it remains to be seen whether it will be best to vary the steam distribution at the expense of an increase in number of parts, or to simplify the construction at the expense of flexibility in the steam distribution to suit varying conditions. There will very soon be some practical experience with the two types, as follows: Vauclain, four cylinders driving one axle, with two valves, two valve-gears; De Glehn, four cylinders driving two axles, with four valves and four valve-gears. As both of these engines are to be operated on the testing plant at St. Louis we may look for interesting results without waiting for records of service on the road."

RESISTANCE OF MATERIALS TO COMPRESSION.

THE INFLUENCE OF LATERAL PRESSURE UPON THE RESISTANCE OF MATERIALS OF CONSTRUCTION TO COMPRESSIVE LOADS.

A. Considère—Académie des Sciences.

WE have already reviewed in these columns the important investigations upon the subject of reinforcing concrete columns by hooping, as conducted by M. Considère, and we now have a further paper by him upon the general subject of resistance to compressive stresses, presented before the French Academy, and published in *Comptes Rendus.*

The subject of resistance to compression is one which will well repay investigation. In the case of tensile stresses it is quite possible to understand how the material may be extended, and how, within the elastic limit, the internal fibre stresses may oppose the external forces. In the case of compression, however, the conditions are not the same. Matter itself is incompressible, and hence external pressure can act only by reducing the voids which may exist in the material, or by causing an increase in some other dimension than that along which the pressure is exerted. Many substances which are commonly regarded as being extremely compressible, are really only readily deformed, and if confined in all directions they would be found highly resistent. An excellent example of this is seen in a form of boiler-tube expander, in which a cylinder of india-rubber is compressed longitudinally by screwing up a central axial bolt. When such a cylinder is inserted into a boiler tube and subjected to longitudinal compression, it increases in diameter, retaining practically the same volume as before, the tube being expanded radially with great force, the rubber being as incompressible as water.

It is this phase of the question which is considered by M. Considère. As he tersely puts it: Solid bodies cannot be compressed longitudinally without the production of transverse swelling. The compression may therefore be resisted by opposing the swelling. In practice the swelling may be prevented by hooping the body under compression. As already stated, M. Considère has demonstrated the truth of this principle by showing experimentally the great increase which may be given to pillars of concrete by wrapping them with a reinforcement of wire. The practical applications of the principle are apparent, and the method has already been accepted as an important contribution to the art of reinforced-concrete construction. With the assistance of MM. Mesnager and Mercier, M. Considère has undertaken further researches into the influence of external pressure as an element in resistance to compression stresses.

In these experiments the external pressure was applied by hydraulic methods, using impermeable prisms immersed in water under pressure. The prisms were made of mortar, containing from 300 to 600 kilogrammes of cement per cubic metre of sand, and were permitted to set for periods of 10 to 126 days. Their form was that of a short pillar, 30 millimetres in diameter, and 80 millimetres long, this length being thought sufficient to avoid errors due to the variable friction between the ends of the pillars and the compressing discs.

In order that the external hydraulic pressure may act in a manner similar to a metallic hooping, it is necessary that the water should not penetrate into the interior of the mortar. This result was secured by coating the rough surface of the concrete with a layer of pure cement, and then applying to this, with the aid of heat, a coating of wax of 1.5 to 2 millimetres in thickness. The piece under test was placed in a vessel containing water, the plunger of the testing machine head entering the vessel through a cupped leather packing. By this arrangement it was possible to submit the exterior of the concrete pillar to any desired pressure, after which the longitudinal pressure could be applied by the testing machine until failure of the specimen took place. In a few of the experiments a sudden drop in the hydraulic pressure showed that the water had penetrated into the interior of the concrete, and in such instances the results were rejected. From sixty-five satisfactory tests M. Considère tabulates results

and plots curves from which he draws interesting conclusions.

The increase in resistance to compression, produced by the opposition of the hydraulic pressure to the swelling, is very marked. Thus a concrete having a crushing resistance of 74.3 kilogrammes per square centimetre under ordinary conditions, was able to resist 227 kilogrammes when surrounded with water at a pressure of 20 kilogrammes per square centimetre, and when the external pressure was raised to 100 kilogrammes the crushing resistance increased to 523 kilogrammes. Similar results were obtained with other experiments and in general M. Considère has framed the following law from the 65 successful experiments: The resistance to crushing of a prism of motor having an ordinary resistance C, is increased to a value A C + 4.8P when subjected to an external pressure P. The coefficient A is equal to unity when the external pressure P is zero, but it increases with the pressure until it reaches a value 1.5 for pressures of 40 to 50 kilogrammes, beyond which pressures it remains constant.

This result confirms in general the experiments made upon wire wrapped pillars, and proves the correctness of the views which have been enunciated concerning that form of reinforcement. In this respect the present experiments are especially valuable, since the method of wire wrapping, although most convenient in practice, hardly lends itself to critical testing methods with the precision attainable by the hydraulic method of reinforcement. These tests go to show what has already been discussed but is not always appreciated; that failure in all cases is due to the forcing of the molecules of the material apart. When the stress is a tensile one the molecules are drawn directly apart; when it is a compression the material is forced apart at an angle to the thrust, the mass of the material acting as a transmitter of the force in a manner similar to a wedge. If a log is being split by a wedge and a hoop of iron is put around the body of the log the end pressure exerted upon the wedge is transmitted as tension upon the hoop. In like manner the compression pressure upon a reinforced concrete pillar may be opposed by circumferential windings, and there is no doubt that this is the strongest manner in which a reinforcement can be applied to structural elements under thrust.

The true principles of reinforcement are those which include the placing of the metallic members in the lines of maximum stress, and M. Considère has done this most effectively in his work.

THE TRANSMISSION OF SUPERHEATED STEAM.

ARRANGEMENTS OF PIPING, INSULATION, AND GENERAL DETAILS FOR MINIMISING HEAT LOSSES IN CONVEYING SUPERHEATED STEAM.

Dr. O. Berner—Verein Deutscher Ingenieure.

IT has long been appreciated that one of the important elements in good steam engineering is the prevention of heat losses in transmitting the steam from the boiler to the engine, and numerous tests have been made as to the merits of different kinds of pipe coverings, as well as upon other appliances. With the later developments in the use of superheated steam it has been found that the heat losses in transmission become especially important and that data obtained from researches with saturated or slightly superheated steam are not altogether applicable to high degrees of superheating. A series of important investigations upon the subject of the conveyance of superheated steam have recently been made in Germany by Dr. Otto Berner, and from articles by him in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* we make some abstracts referring the interested reader to the original papers for the full tables and data of the researches.

When saturated steam is conveyed through long lines of pipe the losses may be determined by observing the drop in pressure, but in the case of superheated steam this is not necessarily the case. The true method of observation in the latter instance is the determination of the drop in temperature. Since the advantages derived from the use of superheated steam in engines de-

pends upon its temperature such determinations are especially desirable in this connection.

Dr. Berner examines the two kinds of heat losses, those by conduction and those by radiation, and deduces a general formula, based on the researches of Péclet, to serve as a guide in the conduct of experimental investigations. To these formulas he applies the results of various investigators, including those of Joule, Pasquay, Dulong and Petit, Stott, and Bolam and Grieve. The researches of Stott, made to determine the transmission of heat through the walls of pipes, avoided the use of steam altogether, the pipe being heated within by an electric current, and the external temperature being determined by the alteration in resistance of an encircling wire, and the result showed that the heat transmission was almost directly proportional to the difference in temperature between the pipe and the external air. Tests of various pipe coverings showed a saving of heat ranging between 78 and 89 per cent. The experiments of Bolam and Grieve give similar results, and further indicate that with high temperatures to be dealt with in superheating the external temperature of the covering should be measured, since it is an indication of the cause of loss. The accurate determination of the temperature of the outside of the pipe covering is not a simple matter, and it is impracticable to use an ordinary thermometer for the purpose; the only reliable method is the electrical determination by the use of thermo-electric elements.

Dr. Berner calls attention to the fact that the actual conductivity of protective coverings for pipes at the present time is determined almost altogether by means of measurement of heat losses in pipes. It is, however, most desirable that the absolute conductivity of the various substances be measured in the physical laboratory, independently of the purposes for which they may be used, and there appears to be no difficulty in making such determinations.

Some general investigations upon this subject have been made by Pasquay upon the elements of which such coverings are usually composed. The latest investigations show that silk and felt form the best protective materials, these, when used in sufficient thickness reducing the heat loss by 80 to 85 per cent. of that of the uncovered pipe. At the high temperatures involved in the use of superheated steam, however, the use of organic substances is inadmissible owing to the fact that they gradually lose their moisture and become charred. This difficulty may be overcome, however, by applying a thin protective covering of some plastic mineral substance to the pipe, using sufficient thickness to protect the hair felt or other organic substance from the direct action of the heated pipe. The poor conductivity of air has rendered it suitable for a pipe covering, the principal point to be observed being the prevention of any movement of the air, since circulation would permit the abstraction of the heat by convection. Experiments by Russner with a layer of air 1 centimetre in thickness show a reduction in heat loss of 75 to 85 per cent. over that of the uncovered pipe. There is little doubt that the efficiency of most of the mineral coverings depends upon the imprisoned air in the pores and interstices of the mass, and in many cases such coverings are doubtless simple means for applying an air jacket.

In making tests of heat losses in the transmission of superheated steam through pipes Dr. Berner gives as the quantities to be subjected to precise measurement: the weight of steam delivered through the pipe per hour; the hourly weight of water of condensation; the steam pressure at the beginning and end of the pipe length and the temperatures of the steam at each end of the pipe. From these data may be computed other important relations, such as the velocity of the steam through the pipe, the hourly loss of heat in thermal units per unit of pipe surface, and in general the loss of energy involved in the transmission. Following the general examination of these elements, he gives in tabular form the data and results of his own investigations, these showing that the transmission of superheated steam through pipe systems originally designed for saturated steam results in losses fully twice as great in the former than in the latter case.

The only remedy at present for this increased transmission loss appears to be greater care in the choice and use of insulating materials, together with a reduction in the length of steam pipe connections to the minimum. Dr. Berner calls attention, how-

and plots curves from which he draws interesting conclusions.

The increase in resistance to compression, produced by the opposition of the hydraulic pressure to the swelling, is very marked. Thus a concrete having a crushing resistance of 74.3 kilogrammes per square centimetre under ordinary conditions, was able to resist 227 kilogrammes when surrounded with water at a pressure of 20 kilogrammes per square centimetre, and when the external pressure was raised to 100 kilogrammes the crushing resistance increased to 523 kilogrammes. Similar results were obtained with other experiments and in general M. Considère has framed the following law from the 65 successful experiments: The resistance to crushing of a prism of motor having an ordinary resistance C, is increased to a value A C + 4.8P when subjected to an external pressure P. The coefficient A is equal to unity when the external pressure P is zero, but it increases with the pressure until it reaches a value 1.5 for pressures of 40 to 50 kilogrammes, beyond which pressures it remains constant.

This result confirms in general the experiments made upon wire wrapped pillars, and proves the correctness of the views which have been enunciated concerning that form of reinforcement. In this respect the present experiments are especially valuable, since the method of wire wrapping, although most convenient in practice, hardly lends itself to critical testing methods with the precision attainable by the hydraulic method of reinforcement. These tests go to show what has already been discussed but is not always appreciated; that failure in all cases is due to the forcing of the molecules of the material apart. When the stress is a tensile one the molecules are drawn directly apart; when it is a compression the material is forced apart at an angle to the thrust, the mass of the material acting as a transmitter of the force in a manner similar to a wedge. If a log is being split by a wedge and a hoop of iron is put around the body of the log the end pressure exerted upon the wedge is transmitted as tension upon the hoop. In like manner the compression pressure upon a reinforced concrete pillar may be opposed by circumferential windings, and there is no doubt that this is the strongest manner in which a reinforcement can be applied to structural elements under thrust.

The true principles of reinforcement are those which include the placing of the metallic members in the lines of maximum stress, and M. Considère has done this most effectively in his work.

THE TRANSMISSION OF SUPERHEATED STEAM.

ARRANGEMENTS OF PIPING, INSULATION, AND GENERAL DETAILS FOR MINIMISING HEAT LOSSES IN CONVEYING SUPERHEATED STEAM.

Dr. O. Berner—Verein Deutscher Ingenieure.

IT has long been appreciated that one of the important elements in good steam engineering is the prevention of heat losses in transmitting the steam from the boiler to the engine, and numerous tests have been made as to the merits of different kinds of pipe coverings, as well as upon other appliances. With the later developments in the use of superheated steam it has been found that the heat losses in transmission become especially important and that data obtained from researches with saturated or slightly superheated steam are not altogether applicable to high degrees of superheating. A series of important investigations upon the subject of the conveyance of superheated steam have recently been made in Germany by Dr. Otto Berner, and from articles by him in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* we make some abstracts referring the interested reader to the original papers for the full tables and data of the researches.

When saturated steam is conveyed through long lines of pipe the losses may be determined by observing the drop in pressure, but in the case of superheated steam this is not necessarily the case. The true method of observation in the latter instance is the determination of the drop in temperature. Since the advantages derived from the use of superheated steam in engines de-

pends upon its temperature such determinations are especially desirable in this connection.

Dr. Berner examines the two kinds of heat losses, those by conduction and those by radiation, and deduces a general formula, based on the researches of Péclet, to serve as a guide in the conduct of experimental investigations. To these formulas he applies the results of various investigators, including those of Joule, Pasquay, Dulong and Petit, Stott, and Bolam and Grieve. The researches of Stott, made to determine the transmission of heat through the walls of pipes, avoided the use of steam altogether, the pipe being heated within by an electric current, and the external temperature being determined by the alteration in resistance of an encircling wire, and the result showed that the heat transmission was almost directly proportional to the difference in temperature between the pipe and the external air. Tests of various pipe coverings showed a saving of heat ranging between 78 and 89 per cent. The experiments of Bolam and Grieve give similar results, and further indicate that with high temperatures to be dealt with in superheating the external temperature of the covering should be measured, since it is an indication of the cause of loss. The accurate determination of the temperature of the outside of the pipe covering is not a simple matter, and it is impracticable to use an ordinary thermometer for the purpose; the only reliable method is the electrical determination by the use of thermo-electric elements.

Dr. Berner calls attention to the fact that the actual conductivity of protective coverings for pipes at the present time is determined almost altogether by means of measurement of heat losses in pipes. It is, however, most desirable that the absolute conductivity of the various substances be measured in the physical laboratory, independently of the purposes for which they may be used, and there appears to be no difficulty in making such determinations.

Some general investigations upon this subject have been made by Pasquay upon the elements of which such coverings are usually composed. The latest investigations show that silk and felt form the best protective materials, these, when used in sufficient thickness reducing the heat loss by 80 to 85 per cent. of that of the uncovered pipe. At the high temperatures involved in the use of superheated steam, however, the use of organic substances is inadmissible owing to the fact that they gradually lose their moisture and become charred. This difficulty may be overcome, however, by applying a thin protective covering of some plastic mineral substance to the pipe, using sufficient thickness to protect the hair felt or other organic substance from the direct action of the heated pipe. The poor conductivity of air has rendered it suitable for a pipe covering, the principal point to be observed being the prevention of any movement of the air, since circulation would permit the abstraction of the heat by convection. Experiments by Russner with a layer of air 1 centimetre in thickness show a reduction in heat loss of 75 to 85 per cent. over that of the uncovered pipe. There is little doubt that the efficiency of most of the mineral coverings depends upon the imprisoned air in the pores and interstices of the mass, and in many cases such coverings are doubtless simple means for applying an air jacket.

In making tests of heat losses in the transmission of superheated steam through pipes Dr. Berner gives as the quantities to be subjected to precise measurement: the weight of steam delivered through the pipe per hour; the hourly weight of water of condensation; the steam pressure at the beginning and end of the pipe length and the temperatures of the steam at each end of the pipe. From these data may be computed other important relations, such as the velocity of the steam through the pipe, the hourly loss of heat in thermal units per unit of pipe surface, and in general the loss of energy involved in the transmission. Following the general examination of these elements, he gives in tabular form the data and results of his own investigations, these showing that the transmission of superheated steam through pipe systems originally designed for saturated steam results in losses fully twice as great in the former than in the latter case.

The only remedy at present for this increased transmission loss appears to be greater care in the choice and use of insulating materials, together with a reduction in the length of steam pipe connections to the minimum. Dr. Berner calls attention, how-

ever, to the effect which transmission losses may have upon tests of comparative performances of engines with saturated and superheated steam. In many cases the increased transmission losses may go far to reduce the gain in the engine, so that the tests should either be made to exclude the transmission altogether, or the efficiency of the transmission of steam from the boiler should be measured separately in each case, so that the true condition of affairs may be understood. There is little doubt that this matter of transmission losses has not been given the same attention as other elements in the use of superheated steam, engineers having devoted themselves with for more activity to the questions of the generation of steam of high temperatures and to engines in which it is to be used than to the conveying it from one point to the other, although this latter operation may have a great influence upon the real gain to be secured.

MILITARY AUTOMOBILES.

MOTOR CYCLES FOR MILITARY PURPOSES—DETAILS OF CONSTRUCTION AND POSSIBLE FIELDS OF USEFULNESS.

Journal of the Royal United Service Institution.

WITH the continual application of machinery and mechanical methods to warfare it was naturally to be expected that motor vehicles would be considered as available for service. Already the subject has been actively discussed, and various papers and reports of trials have been reviewed in these pages. An interesting contribution to the subject is found in a recent paper by Lieutenant H. G. de Watteville, in the *Journal of the Royal United Service Institution*, discussing especially the availability of the motor cycle for military purposes.

In considering the use of motor vehicles in warfare a clear distinction should be made between the different kinds of machines. Motor cars have been seriously considered for some time on the Continent, while in South Africa the traction engine has been employed.

"The car and the cycle should not be classed together as one type of vehicle; but they rather form two very distinct groups of one class. The petrol motor is the only link between the two. The motor cyclist and the motor car driver should be kept distinct; just as the cavalry private is not to be confounded with an Army Service Corps driver. This does not mean the exclusion of the car from the combatant ranks; far from it, for there would seem to be a great opening for the rapid conveyance of troops by its aid. But the motor cycle, in spite of its mechanical nature, must not be considered to work with success and efficiency only when used by the Royal Engineers, or by a purely technical corps. It is in this particular that the cycle and car differ fundamentally; the motor driver on the cycle remains first and foremost a soldier, on the car he is a mechanician doing military work. The striking feature of the motor cycle of to-day is its extraordinary simplicity. Notwithstanding an appearance of complexity, it is wonderfully easy for a man of average intelligence to learn the tricks of the engine, and to become an expert motor cyclist in a very short period. In a given space of time it would be easier to train an efficient motor section than a similar mounted infantry unit out of the same material. The motor car driver, on the other hand, requires a far longer training; and when actually at work, cannot give his mind to anything beyond his engines, while the motor cyclist is able to watch the country, and can get off in an instant, thus becoming a dismounted combatant at a moment's notice. The motor cycle can go wherever the car can go; it can, moreover, instantly turn in a narrow road or on a road occupied by troops; it can go along a footpath, across grass, through narrow gates; it can even be lifted over certain obstacles by two men: all these, or at any rate most of these difficulties are unsurmountable for the car. The cycle burns far less petrol—its daily supply will only take an average car some twenty or thirty miles. The cycle can quickly be concealed behind bushes and hedges. The car is far more conspicuous; it frequently raises a trail of dust which

obscures the view, and hangs in the air for an appreciable time after its passage. The cycle has little more to fear from side-slip than many species of cars. Its repairs and spare parts are few and extremely simple. In even moderately skilled hands the motor cycle of to-day has been amply proved to be a reliable machine."

The use of the motor cycle in military operations is necessarily diversified. Probably the most immediate use of the machine is in connection with isolated services, such as orderly duties, carrying messages, and aiding in prompt communication. With this comes scouting work, for which the motor cycle appears to be especially adapted. Speed and fairly long radius of action are desirable for this work. With a good machine a man alone may do excellent work. He can leave his machine, use his field glasses, and be on the move again in a few seconds at full speed, while if necessary the machine may be hidden while a reconnoissance is made on foot. The principal objection to the motor cycle for this work is found in the fact that the machine is closely limited to the road. The noise of the motor is also objectionable, and for military machines every effort should be made to reduce it to a minimum.

The use of sections of motor cyclists in action is a more debatable matter, although it presents possibilities. The principal difficulty appears to be that of effecting concerted action, although small bodies of men, not exceeding 30 in number, might be found manageable. This is a question, however, which might well be solved by practical experience in manœuvres and drill, and the value of the information would well be worth its cost.

There are a number of miscellaneous uses for the motor cycle which may probably be the first for which it will be generally employed. Thus the combination of motor men with a signalling corps may well replace mounted signallers, who have already shown their usefulness. This work may be extended to include the use of the heliograph, and this field offers increasing possibilities. Motor vehicles may also be used in connection with engineering work in the field, and numerous special applications will occur to the thoughtful officer.

"The requirements of the military motor cycle are all such that tend towards reliability and simplicity. Excessive speed is not wanted; 25 miles per hour should be the maximum aimed at, rather than 40. Solidity of detail is to be preferred to attractive and less robust models. Air-cooled engines should be retained; water-cooling adds weight, complication, and is far more vulnerable. Weight must be avoided, though not beyond the limits imposed by common sense. Pedals must be fitted to all military machines, though footrests are a comfortable change, and should be added. Even at very high speeds the pedals will be found to remain stationary when the feet are removed—at any rate, on the majority of cycles. A petrol and oil capacity for 150 miles, running over give-and-take roads, should be the minimum. A free engine, that is, a device whereby the cycle can be pedalled or allowed to run free down hill without the engine being in motion should be extremely useful. It would allow a broken-down machine to be pedalled immediately, or also a sound machine, where absolute silence is required; it renders pushing a motor bicycle an easy matter. These points cannot be ignored in military work. Similarly, a two-speed gear —if the new attempts in this direction should lead to success—would be highly desirable. It would enable a lighter machine altogether to do good work over hilly country; the two-horse motor would be found equal to the elephantine three-horse bicycle that has been in vogue during the late season. As it is, two or two-and-a-quarter horse-power should suffice for all military bicycles, provided that the equipment of the man is kept light, that the man himself weighs not more than eleven stone, that the bicycle is not geared high, and that no trailer work is contemplated. A two or three-speed would make the two-horse motor an ideal bicycle engine; but the gear must be thoroughly sound. No hill should then prove too much, even to a heavy rider with a full kit with him. On the vexed question of belt or chain transmission, it is difficult to give a confident opinion. The chain is certainly stronger on hills, and works well in wet weather. When in good condition, the belt is almost as good and far simpler; belt repairs, though vexatious, are effective, and quickly done. A defec-

tive chain clutch, on the contrary, entails skilled assistance. The wear on the engine and driving tyre is perhaps the chief drawbacks to the chain. The former can be minimised partly by good construction and partly by skilled driving, the latter necessitates a tyre of either stronger fabric or covered by a special band. The balance is perhaps in favour of the chain. The tyres are, indeed, a great weakness of the motor cycle, but this should be obviated by improvements; perhaps the Wilkinson tread or the Samson Hutchinson bands are the best puncture preventers known; they are also said to minimise side slip. Tyres for military use should be of at least 2¼-inch section.

"The question of noise is mainly a matter of manufacture; and there is not the least doubt that this can be reduced to a very slight audible beat. There is a vast difference in this respect between the productions of various firms. Ease of starting is of paramount importance; this can be greatly assisted by a free engine and chain drive, also by an efficient valve for injecting paraffin into the cylinder when starting work. One detail must not be overlooked —that is, a good prop to support the machine when dismounted, though to the uninitiated this may seem unnecessary. But a motor bicycle, being so much heavier than the ordinary cycle, such a contrivance is for rapid work an absolute necessity. It should take the form of a swinging rod fastened below the saddle to the frame, and held back by a clip when not in use."

Like everything else, the military motor cycle must be an evolution from the existing appliance in accordance with the special conditions of the service, but the time for the evolution is before the demand comes for actual service, and before the skilful use of the machine by the enemy shall have made the experience unnecessarily expensive.

THE EQUIPMENT OF MINING LABORATORIES.

PRACTICAL SUGGESTIONS UPON THE USE OF THE LABORATORY IN SCHOOLS OF MINING AND METALLURGY.

H. S. Munroe—Engineering and Mining Journal.

WHEN the term laboratory was used many years ago it was always supposed to refer to the chemical laboratory, but the scope of the word has become so extended of late that it has become necessary to explain the department of work to which the term is applied. In nearly all educational institutions there are several laboratories, and indeed the chemical laboratory is often overshadowed by the larger and more pretentious mechanical and physical departments.

The employment of laboratory teaching for the departments of mining and metallurgy involves really a combination of mechanical and chemical methods and appliances, and the subject of the equipment and use of such a laboratory forms the subject of a paper in a recent issue of the *Engineering and Mining Journal* by Professor H. S. Munroe, of Columbia University.

Professor Munroe summarizes the objects of the mining laboratory under three heads: the experimental demonstration of fundamental principles and laws; the training of the student in the methods of scientific testing and examination; and the conduct of original investigation and research.

"Under the first head, the object of laboratory teaching is to supplement the classroom work and add to its efficiency. Under the second head, the object sought is chiefly the training of hand and eye in laboratory manipulation, while under the third head the purpose is to add to the sum of scientific and professional knowledge.

"One important question to be decided is the scale of operation—shall the work be done on a small scale with laboratory apparatus, as in chemical and assay laboratories? Or shall we introduce full-sized machinery and attempt to reproduce actual working conditions in laboratory work? Or shall we adopt some compromise scale for our apparatus and methods?

"The study of physical and chemical phenomena usually can be conducted as well on a small scale as on a large one, provided our instruments and methods are sufficiently delicate and refined.

"The testing of engineering materials and the determination of the chemical constitution and physical properties of minerals and ores can be done as well on a small scale as on a large, if only we can secure small samples for our tests that will fairly represent the larger amounts to be treated.

"The testing of machines and processes can sometimes be done on a small scale, but the results of such small scale tests are often of doubtful value, and generally need to be confirmed by tests on a large scale.

"Work on a laboratory scale requires less room, less expensive apparatus, and takes less time and much less work than large scale operations. Small scale work is thus much to be preferred when results of equal value can be secured thereby. On the other hand, large machines and full scale working tests are sometimes indispensable, and in such case must be provided at any cost."

Professor Munroe is undoubtedly in favor of a laboratory provided with large machines, in order that the student may become familiar with the actual operations which he may subsequently be called upon to conduct. In this way much time is saved which would otherwise be expended in visits to shops and works, while the conditions for work and investigation may be made much more favorable than would be possible under actual working surroundings. There is no difficulty in adding to the full sized plant the necessary small scale laboratory, and the true plan is undoubtedly found in a combination of both systems.

The equipment of the mining and metallurgical laboratory at Columiba University is described at length, showing how the combination of a carefully arranged laboratory fitted for accurate work on the small scale is extended by the provision of an installation of crushing, sampling, and concentrating machinery of full working size. Full sized classifiers, settlers, automatic feeders, and centrifugal pumps for supplying these machines with water and ore are provided, and the whole plant is arranged to be run continuously when desired, without requiring large amounts of water or ore, the same material and the same water being used again and again.

"With each of these machines the student makes a series of experiments designed to bring out the physical laws governing successful working, to afford instruction in practical details of operating the machines, and to give opportunity for engineering tests of capacity and efficiency under different conditions of treatment.

"These include the adjustment and regulation of the ore supply, of the feed and wash water, of speed, stroke, and other working conditions to the treatment of different ores and different grades of sand and pulp. In this work the student is taught to recognize the symptoms of irregular working, to diagnose the trouble with the aid of laboratory tests, and to apply the proper remedies. He makes, incidentally, numerous tests of capacity and efficiency, taking frequent samples of ore-feed, and of the different products for quantitative examination, and weighs and measures the ore and water supply and products obtained."

The advantages of this system over that of occasional visits to various works will be apparent, and the only point which appears to be necessary is the active effort of the professor and the instructors to keep the plant up to date, both in equipment and operation. When such a laboratory is allowed to get into a monotonous routine it may fail to fulfil its purpose, but when, as is the case at Columbia, the work is conducted with active and definite purpose, it cannot fail to become a valuable auxiliary.

"The installation of working machines in the engineering school has, incidentally, other advantages. For example, they not only illustrate the lectures on engineering subjects, but in addition serve in the place of much descriptive matter, details of construction, adjustment and operation, with the advantage that the students' conceptions are clearer, false impressions are avoided, and the instructor has more time to devote to critical discussion. Finally, a proper equipment of engineering laboratories should be such as to enable the staff and advanced students to undertake important original investigations of ore dressing questions, many of which await solution. A beginning has been made, at Columbia and elsewhere, in this direction, and it is hoped that much valuable work of this character may be accomplished in the near future. In many cases the machines in these laboratories have been especially designed to facilitate such researches."

ELECTROLYTIC IRON.

THE COMMERCIAL PRODUCTION OF CHEMICALLY PURE IRON BY ELECTROLYTIC PROCESSES AND ITS APPLICATIONS IN THE ARTS.

American Electrochemical Society.

THERE have been numerous attempts to employ the electrical current in the smelting of iron and steel, and some of these have shown sufficient merit to demand interested attention. Another application of electricity in a similar direction is the production of chemically pure iron by the method of electrolytic deposition, and this forms the subject of an interesting paper presented before the American Electrochemical Society by Messrs. C. F. Burgess and Carl Hambuechen.

The deposition of iron by the electric current has been effected many times as a laboratory operation, but recent experiments in the laboratory of applied electrochemistry of the University of Wisconsin show that electrolytic iron can be produced in such quantities and at such a cost as to make it a material of commercial importance.

Until recently the only practical applications which have been made of the process of electroplating with iron have been in the so-called steel facing of dies and electrotypes. The coating thus deposited is not really steel, but consists of pure iron containing occluded hydrogen, the presence of the hydrogen being supposed to cause the hardness which renders it useful for these purposes. The manner in which the hydrogen is held is not definitely understood, but it may be present in quantities equal to several hundred times the volume of the metal, and it may be almost entirely removed by the application of heat.

The authors whose paper is referred to have undertaken a more extended research, and for more than two years they have carried on a series of investigations upon the production of pure iron in quantity by the electrolytic process. Experiments with a variety of iron salts at different current densities, temperatures, and working conditions have been made and the following method adopted as the most satisfactory:

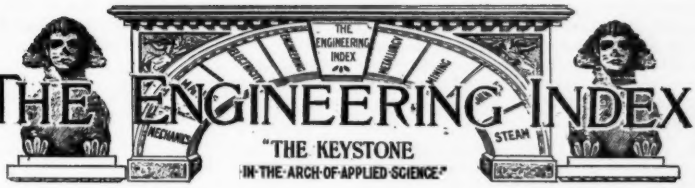
"The electrolyte consists of ferrous ammonium sulphates; the current density at the cathode is six to ten amperes per square foot of cathode surface, and at the anode slightly less; the electromotive force for each cell is slightly under one volt; the temperature of electrolyte is about 30° C.; the anodes consist of ordinary grades of wrought iron and steel; the starting sheets for the cathodes are of thin sheet iron previously cleaned of rust and steel."

The cost of the process appears to have been determined at about one-half cent per pound of iron, not including fixed charges on the plant, it being thus not greatly in excess of the cost of refining copper, and chemical analysis shows the product to have a purity in excess of 99.9 per cent. The presence of the occluded hydrogen, as has already been said, makes the metal almost as hard as steel, and so brittle that it can readily be shattered with a hammer. After the hydrogen has been removed by heating the metal becomes softer, assuming properties of malleability and toughness similar to those of Swedish iron.

It is possible that the pure iron thus obtained may be found useful for electrical purposes. Experiments have shown that the hysteresis, permeability, and electrolytic resistance are greatly affected by the amount of hydrogen present, but quantitative investigations upon these points are as yet incomplete. It would be interesting to have metallographic studies made of various examples of electrolytic iron, since some useful comparisons with iron alloys might be made.

It having been shown that it is possible for electrolytic iron to be produced at small cost, the question naturally arises as to what uses there may be for it. The first suggestion which naturally presents itself is that on account of its purity it would serve as a basis for investigating the properties of iron and its alloys.

Starting with pure iron, alloys of a predetermined and definite composition can be produced, thus making such investigations of greater simplicity. At the moderate cost above given it may be used for manufacturing chemically pure compounds, and for standardizing laboratory solutions.



The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING	443	MARINE AND NAVAL ENGINEERING	456
ELECTRICAL ENGINEERING	449	MECHANICAL ENGINEERING	458
GAS WORKS ENGINEERING	454	MINING AND METALLURGY	467
INDUSTRIAL ECONOMY	455	RAILWAY ENGINEERING	471
STREET AND ELECTRIC ENGINEERING	474		

CIVIL ENGINEERING

BRIDGES.

Arch.

A Statical Investigation of Arches of Constant Dimensions (Statische Untersuchung von Gewölben nach dem Verfahren mit Konstanten Bogengrossen). Dr. Robert Schönhöfer. An analytical and graphical study of the statics of the masonry arch, according to the elastic theory of Müller-Breslau. 2500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—April 2, 1904. No. 62248 D.

Calculation of the Stresses and Design of Railway Structures of Steel Concrete. Walter W. Colpitts. The discussion has particular reference to the parabolic arch, although in a general way it indicates the manner in which stresses may be investigated in arches of other curves. Ills. 2800 w. Ry Age—April 1, 1904. Serial. 1st part. No. 61871.

Cantilever.

A Cantilever Plate-Girder Highway Bridge. Illustrated description of a bridge in Kansas City, Missouri, which crosses two tracks of railway. 900 w. Eng Rec—April 9, 1904. No. 62024.

We supply copies of these articles. See page 476.

Erection.

Erecting Bridge Spans by Sliding Them Forward from the Shore. Illustrations of a bridge in Queensland erected in this way with accounts of other erections, especially a parallel case from Finland. 1000 w. Eng. News—April 21, 1904. No. 62175.

Ferry Bridge.

The Proposed Ferry Bridge at Bordeaux. Brief illustrated description of a bridge of the transporter type. 700 w. Eng Rec—April 9, 1904. No. 62021.

Highway Bridges.

Highway Bridges in the Croton Valley. Illustrates and describes the bridges made necessary by the new Croton dam water supply for Greater New York. 4000 w. Eng Rec—April 23, 1904. No. 62376.

Inspection.

The Value of Inspection of Metal Bridges During Construction and Erection. Walter L. Golden. Explains the various stages of inspection work in mill, shop and field, and gives information showing its value. 8500 w. Jour Assn of Engng Socs—March, 1904. No. 62313 C.

Plate-Girder.

A Long-Span Double-Track Plate-Girder Bridge. Illustrated description of a bridge of the Chicago Terminal Transfer Company and the method of transporting. 800 w. Eng Rec—April 16, 1904. No. 62132.

Regulations.

New Official Regulations for Railway Bridges in the Prussian State. Considers some of the more prominent points in the new official regulations. 1500 w. Engr, Lond—March 25, 1904. No. 61938 A.

Rolling-Lift.

Construction of a Scherzer Double-Roller Lift Bridge at Middle Seneca Street, Cleveland Ohio. William J. Carter. An illustrated account of the difficulties encountered in building the bridge, principally the substructure. 2500 w. Jour Assn of Engng Socs—March, 1904. No. 62311 C.

The Construction of the Scherzer Lift Bridge at Newark Bay. Describes the rolling-lift bridge being built by the Central Railroad of New Jersey to replace a steel truss center-piece swing span. 2700 w. Eng Rec—April 2, 1904. No. 61809.

Suspension.

The Elizabeth Bridge, Budapest. Begins an illustrated description of a suspension bridge presenting various novel engineering features, giving also historical sketch. 1800 w. Engr, Lond—April 15, 1904. Serial. 1st part. No. 62341 A.

Trestle.

The Reconstruction of a Timber Trestle. B. B. Boyd. Illustrated description of this work as carried out on the Southern Pacific Railroad in California. 800 w. Cal Jour of Tech—April, 1904. No. 61975 C.

Viaducts.

Experience in the Erection of American Viaducts on the Uganda Railway. A. B. Lueder. The writer was in charge of the work of erection, and gives an interesting report of his experiences. 3700 w. Eng News—April 14, 1904. No. 62046.

The Eggenburg Viaduct on the Vienna-Eger Railway (Der Eggenburger Viadukt im Zuge des Zweiten Gleises der Eisenbahnlime Wien-Eger). Karl Stöckl. Illustrations and details of continuous girder viaduct constructed for the second track of the Vienna-Eger railway; with data and results of tests. 5000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—April 9, 1904. No. 62249 D.

CONSTRUCTION.

Buildings.

Structural Engineering in Apartment-House Construction. Editorial discussion of phases of construction in current practice in New York, with illustration of a typical building. 2500 w. Eng News—April 14, 1904. No. 62048.

The Extension of the Imperial Hotel, New York. Illustrated detailed description of important features of the work. 3300 w. Eng Rec—April 16, 1904. Serial. 1st part. No. 62131.

Building Laws.

Some Comments on Building Laws. Gunvald Aus. Remarks on engineering points in the New York building code. Elaborated from an address in the Brooklyn Chapter of the Am. Inst. of Archts. 3500 w. Eng News—April 14, 1904. No. 62050.

Central Stations.

The Design and Construction of Buildings Connected with the Generation and Supply of Electricity Known as Central Stations. C. Stanley Peach. Abstract of paper discussing this subject, read before the Royal Inst. of British Architects. 3500 w. Arch't, Lond—April 1, 1904. No. 62055 A.

Chimneys.

Smokey Chimneys. Hastwell Grayson. Reviews the principles of flues, and the causes of smoky chimneys. 2800 w. Jour Ry Inst of Brit Archts—March 19, 1904. No. 61999 B.

Concrete Construction.

Concrete Construction in Yellowstone National Park. Brief description of work in the roads, bridges and other structures in which concrete has been used. 1800 w. Eng Rec—April 2, 1904. No. 61808.

Concrete-Tanks for Acid Liquor Under Pressure. A. C. Arend. Drawings and explanation. 700 w. Eng News—April 21, 1904. No. 62182.

Concrete Work in Cuba and Yucatan. C. E. McDowell. Gives illustrations of work, with descriptive notes. 1100 w. Munic Engng—April, 1904. No. 62087 C.

Crowds.

Some Recent Tests of the Weight of Crowds. L. J. Johnson. Describes in detail a series of three tests made to determine the weight of crowds per sq. ft. of surface. 1600 w. Eng News—April 14, 1904. No. 62049.

Domes.

Theory of the Spherical Dome with a Homogeneous Surface, and of the Framed Dome; Also Notes on the Construction of Masonry and Metal Domes. Continued discussion of paper on this subject by E. Schmitt. 3200 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62328 E.

Earth Pressures.

Lateral Earth Pressures and Related Phenomena. E. P. Goodrich. Describes experimental investigations made to obtain facts that may be relied upon. 9000 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62324 E.

Earthwork.

Earthwork at the Washington Filtration Works. E. D. Hardy. A report of excavation work, filling, &c. Illustrated. 800 w. Eng Rec—April 16, 1904. No. 62133.

Fireproofing.

The Baltimore Fire. Charles A. Miller, Jr. An illustrated account of this $85,000,000 fire, describing the buildings, and commenting on the lessons to be learned. 6000 w. Archts & Bldrs Mag—April, 1904. No. 61945 C.

The Rochester Conflagration. An illustrated report of the fire of Feb. 26, which destroyed property to the value of $3,200,000. 2800 w. Fire & Water—April 9, 1904. No. 61977.

Foundations.

Safeguarding the Foundations of Trinity Church Spire, New York City. Illustrates and describes methods of protecting these foundations, which are in dry, sandy soil, from undermining during the construction of the rapid transit subway. 700 w. Eng Rec—April 9, 1904. No. 62023.

The Reconstruction of Foundations for the Hotel Wollaton, Brookline, Mass. Dana M. Pratt. Describes the conditions prevailing and the repairs made to render the building safe. Ills. 6800 w. Jour Assn of Engng Socs—March, 1904. No. 62310 C.

Freezing.

Freezing as an Aid to Excavation in Unstable Material. Discussion of a paper by James H. Brace on the above subject. 3800 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62327 E.

Grain Elevators.

Fireproof Grain Storage Elevator for the Canadian Northern Railway, Port Arthur, Ont. R. M. Pratt. From a paper read before Can. Soc. of Civ. Engrs. Descriptive. 3500 w. Can Engr—April, 1904. No. 62035.

Power Production and Transmission in the Stuyvesant Elevator, New Orleans. Describes an elevator with a capacity of 1,500,000 bushels in which the rope system of power transmission was adopted. Ills. 2500 w. Eng Rec—April 9, 1904. No. 62020.

Recent Grain-Elevator Construction (Installations Récentes de Grands Magasins à Blé). A. Bidault des Chaumes. Describing especially the new warehouses at Frankfort, Strasburg, and Genoa, with details of construction. 2000 w. 1 plate. Génie Civil—March 26, 1904. No. 62213 D.

The Canadian Pacific Grain Elevator at Port Arthur, Ontario. Illustrates and describes an elevator designed to meet special conditions, having a capacity of 443,000 bushels, and its construction. 2800 w. Eng Rec—April 9, 1904. No. 62018.

Pile Driving.

Driving a Test Pile for the Hudson River Tunnel. Interesting illustrated description of a test pile driven at Weehawken. 800 w. Sci Am—April 23, 1904. No. 62196.

Roofs.

New Appliances for Re-roofing Shops Without Stopping Work. Describes the work as carried out at Leeds by specially designed machinery. Ills. 1000 w. Sci Am Sup—April 2, 1904. No. 61863.

Shoring.

A Unique Case of Shoring Work on a New York Telephone Building. An illustrated description of method used in enlarging the "Madison Square" Station, in which a brick and iron building was swung up from overhead rather than shored up from below in order to remove certain parts of its walls. 1300 w. Eng News—April 7, 1904. No. 61997.

Tunnels.

The Hudson River Tunnel. An illustrated article, giving briefly the history of this work, begun thirty years ago and now approaching completion. 1800 w. Sci Am Sup—April 2, 1904. No. 61860.

The Originator of the Hudson River Tunnel. Brief review of the early history of this work, calling attention to names

We supply copies of these articles. See page 476.

deserving record in connection with this undertaking. 1000 w. Eng News—April 7, 1904—No. 61998.

MATERIALS OF CONSTRUCTION.

Brick.

Sand-Lime Brick from a Brickmaker's Point-of-View. Daniel P. De Long. Read at Cincinnati meeting of the Nat. Brick Mfrs. Assn. Discusses the value of this material. General discussion. 4400 w. Am Archt—April 16, 1904. No. 62167.

Cement.

Portland Cement and Its Uses in Engineering Construction. E. Kuichling. The present article reviews the investigations made by S. B. and W. B. Newberry. 3500 w. Munic Jour & Engr—April, 1904. Serial. 1st part. No. 61873 C.

Portland Cement. Presidential address of David Butler Butler before the Soc. of Engrs. (England). On the manufacture, testing, uses, applications, &c. 3200 w. Am Archt—April 2, 1904. No. 61852.

The Fallacy of the Tests Ordinarily Applied to Portland Cement. Richard K. Meade. Read before the Lehigh Valley Sec. of the Am. Chem. Soc. Discusses some of the false conclusions that may be drawn from a too rigid interpretation of the results of tests. 3500 w. Eng Rec—April 2, 1904. No. 61806.

Concrete Plant.

A Concrete Mixing Plant for a Power House Foundation. Illustrated description of the plant for mixing and placing concrete in foundations of power house at Long Island City. 1500 w. Eng Rec—April 9, 1904. No. 62019.

Reinforced Concrete.

Cross-Bending Tests on Steel-Concrete Beams. Illustrates and describes tests made by Prof. Malverd A. Howe of concrete beams reinforced with corrugated steel bars. 1500 w. R R Gaz—April 8, 1904. No. 62003.

Reinforced Concrete Roof for a Locomotive Roundhouse, Long Island R. R. Illustrates and describes the material and methods of construction. 1200 w. Eng News—April 14, 1904. No. 62051.

The Design of Concrete Steel Arches. E. J. McCaustland. Read before the Am. Assn. for the Adv. of Science. Reviews investigations made by W. S. Edge, in an attempt to determine the most economical proportions of the arch ring, and also to investigate the elastic stresses under moving loads with a view of determining the position of loading which will make these stresses a maximum. 2800 w. Eng News—April 21, 1904. No. 62177.

Testing.

Tests of Sand-Lime and Sand-Cement Brick and Concrete Building Blocks. A. Marston. Abstract of a paper read at meeting of the Iowa Brick & Tile Mfrs. Assn. Results of tests are given with explanatory remarks. 800 w. Eng News—April 21, 1904. No. 62184.

Timbers.

Combustibility of Timbers. G. Rodney Cherry. Describes tests made and gives valuable data and tables of comparison. 1500 w. Ins Engng—April, 1904. No. 62367 C.

MEASUREMENT.

Stream Flow.

Canal and Stream Measurements. A. P. Stover. Describes the two methods most commonly employed by engineers—the measuring weir, and the current meter, also briefly notes other methods. 4000 w. Cal Jour of Tech—April, 1904. No. 61-970 C.

Method of Computing Daily and Monthly Discharge of Streams with Sandy, Changeable Bed. E. C. Murphy. Brief description of two methods devised by hydrographers of the U. S. Geological Survey for such conditions. 1200 w. Eng News—April 21, 1904. No. 62179.

Surveying.

Practice in Re-establishing and Monumenting a Railway Center Line. Albert I. Frye. Explains a feature which has proved convenient and effective in adjusting the center lines of tangents. 600 w. Eng News—April 14, 1904. No. 62047.

Transit.

Desirable Features in a Transit for Topographical Surveys. George Jacob Davis, Jr. Reviews the requirements of a telemeter and of other improvements introduced, with the hope of aiding in the development of a standard form of stadia instrument. Ills. 1800 w. Eng News—March 31, 1904. No. 61846.

MUNICIPAL.

Pavements.

Street Pavements. Louis M. Pfeiffer. From a paper before the Colorado Polytechnical Assn. Reviews the various materials used, their advantages and disadvantages, and claims much for the bitulithic pavement. 3000 w. Munic Engng—April, 1904. No. 62089 C.

Sewage Disposal.

Notes on the Sewerage System of Worcester, Massachusetts. Concerning the construction work carried on during 1903, and the maintenance and operation of the disposal plant. Ills. 2500 w. Eng Rec—April 23, 1904. No. 62378.

Refuse and Sewage Disposal Station. Col. W. F. Morse. Illustrates and describes a plant at Bolton, England, where

We supply copies of these articles. See page 476.

power is obtained from sewage, sludge and refuse, with economy. 2000 w. Munic Jour & Engr—April, 1904. No. 61872 C.

Sewage Disposal Works and Experiments at Andover, Mass. An illustrated description of the works and an account of experiments which proved that with the somewhat stale sewage which reached these works septic-tank action was not favorable to subsequent purification. 3500 w. Eng Rec—April 23, 1904. No. 62377.

Sewage Pumping Plant for the Jackson Park Ave. Sewage District at Chicago. Illustrated detailed description. 2500 w. Eng News—March 31, 1904. No. 61847.

Some Observations of Sewage Farming in England. A résumé of facts regarding sewage farming, describing some of the farms visited. 3800 w. Eng News—April 21, 1904. No. 62183.

Sewers.

Extensions of Brooklyn Sewerage System: Avenue G Trunk Sewer. An illustrated detailed description of deep-trench work and sewer construction. 2800 w. Eng Rec—April 16, 1904. Serial. 1st part. No. 62126.

WATER SUPPLY.

Aqueducts.

Geology of the Weston Aqueduct of the Metropolitan Water Works in Southboro, Framingham, Wayland, and Weston, Massachusetts. W. O. Crosby. A record of the character and structure of the hard rocks which were exposed during the construction; especially the geology of the tunnels. Ills. 7000 w. Tech Qr—March, 1904. No. 62358 E.

Petrographical Notes on the Rocks of the Weston Aqueduct. C. H. Warren. Gives results of a microscopical study of some of the igneous rocks met with in the tunnels. Supplementary to paper of W. O. Crosby. 2600 w. Tech Qr—March, 1904. No. 62359 E.

Arid Regions.

Potable Waters in Arid Regions. J. E. Roadhouse. Describes the conditions in Imperial Valley, Cal., and the problem of preparing pure drinking water. 1800 w. Cal Jour of Tech—April, 1904. No. 61976 C.

Dams.

Lake Cheeseman Dam and Reservoir. Charles L. Harrison and Silas H. Woodard. The first named gives the history, design and illustrated description of the construction; the second gives an analysis of stresses in Lake Cheeseman dam. 12000 w. Pro Soc of Civ Engrs—March, 1904. No. 62325 E.

Rebuilding the Portman Dam near Anderson, S. C. John L. Shepparu, Jr. Describes the first dam built and its enlargement, and the failure of the composite dam, giving an illustrated description of the rebuilding. 3500 w. Eng Rec—April 2, 1904. No. 61803.

The Barossa Arched Concrete Dam in South Australia. Alex. B. Moncrieff. Illustrated description of the highest arched concrete dam in Australia, with information concerning it. 1000 w. Eng News—April 7, 1904. No. 61991.

The Five Dams and Wood Stave Conduit of the Southern California Mountain Water Co. An outline of the completed and projected works of this company, describing the five dams and giving details of the wood stave conduit. Map and illustrations. 2000 w. Eng News—April 7, 1904. No. 61996.

Derwent Valley.

The Derwent Valley Water Works System, Derbyshire. An illustrated article describing one of the largest supply projects under construction in England. Includes five reservoirs with a combined capacity of 10,000,000,000 imperial gallons, five large masonry dams, nearly 60 miles of conduits and several acres of filters. 3300 w. Eng Rec—April 9, 1904. No. 62016.

Filters.

Levi Mechanical Filters at Charleston-Kanawha, W. Va. Illustrated description of plant of the pressure type. Revolving bars are used to prevent clogging of the screening system by sand. 700 w. Eng News—April 7, 1904. No. 61993.

Ground Water.

Development of an Underground Water Supply for Penzance, England. From a paper by Frank Latham, before the Soc. of Engrs., describing his experiences in this work. 2800 w. Eng Rec—April 16, 1904. No. 62130.

Ithaca, N. Y.

Recent Concrete-Steel Water-Works Construction at Ithaca, N. Y. Illustrated detailed description. 5000 w. Eng Rec—April 9, 1904. No. 62017.

Irrigation.

Irrigation in the North-West Territories of Canada. Showing the importance, extent and value of the work. 900 w. Engr, Lond—March 18, 1904. Serial. 1st part. No. 61937 A.

London.

The London Water-Works Acquirement. R. Price-Williams. A discussion of this undertaking, its extents, capability, and probable benefit to London. 2500 w. Engng—April 15, 1904. No. 62353 A.

Pipe Arch.

The Weston Aqueduct Pipe Arch Over the Sudbury River, Massachusetts. Illustrates and describes the construction of a

We supply copies of these articles. See page 476.

pipe designed to span the river as a tubular arch to convey water across. 2000 w. Eng Rec—April 16, 1904. No. 62129.

Pollution.

The Value of Tests for Bacteria of Specific Types as an Index of Pollution. Extracts from a special report by H. W. Clark and Stephen De M. Gage in the annual report of the State Board of Health of Massachusetts for 1902. 2000 w. Eng Rec—April 16, 1904. No. 62134.

Protection.

Protection of Water Supplies. J. Cartwright. Presidential address before the Manchester Assn. of Students of the Inst. of Civ. Engrs. Points out sources of pollution, and considers how they may be safeguarded. 2500 w. Sanitarium—April, 1904. No. 62093 D.

Pumping Engines.

See Mechanical Engineering, Hydraulics.

Rainfall.

Rainfall and Run-Off from Catchment Areas in New England. L. M. Hastings. Explains methods of determining the average rainfall, and matters of related interest. Diagrams, tables and discussion. 7000 w. Jour New Eng W. Wks Assn—March, 1904. No. 62097 F.

Reservoirs.

Notes on the Construction of a Storage Reservoir. W. H. Richards. Illustrates and describes such portions of the construction as are somewhat unusual. 1700 w. Jour New Eng W Wks Assn—March, 1904. No. 62098 F.

Progress in Construction of Jerome Park Reservoir, New York City. Information concerning this engineering work with illustrations showing the progress and present condition of the work. 3500 w. Eng Rec—April 23, 1904. No. 62374.

Waste.

Requisite Amount of Water for a Public Supply. J. Herbert Shedd. Discusses the evils of water waste and means of limiting the supply to useful purposes. Gives the experience of Providence, R. I., and facts in regard to the conditions. General discussion. 8400 w. Jour New Eng W. Wks Assn—March, 1904. No. 62095 F.

Water-Works.

Village Water-Works of Geneva, Ohio. Illustrates and describes details of the reservoir and intake, giving plan and section of pumping and filtration plant. 2200 w. Eng Rec—April 2, 1904. No. 61804.

WATERWAYS AND HARBORS.

Breakwater.

The Breakwater at Buffalo, New York. G. H. Raymond and George E. Fell. Continued discussion of a paper on this subject by Emile Low. 2500 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62326 E.

Canal Lifts.

Lifts on the Moravian Canals (Ueber das Schiffsheben auf Mährischen Kanälen). Anton Smrcek. Discussing especially the comparative advantages of locks, lifts, and inclined planes for the Danube-Oder canal system. 5000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—April 9, 1904. No. 62250 D.

Canals.

The Barge Canal Across New York State. Plan showing the route of the canal, with particulars concerning changes, difficulties, etc. 2500 w. R R Gaz—April 8, 1904. No. 62004.

Trent Valley Canal. J. Alexander Culverwell. Map and description of this route which will shorten the transportation from the Great Lakes to the Ocean. It will accommodate barges of 800 tons, and the total cost of the work will be $9,000,000, of which $4,000,000 has been already expended. 1500 w. Can Elec News—April, 1904. No. 62361.

Canal Traction.

Electrical Equipment for Cornwall Canal. F. H. Leonard, Jr. Abstract of paper read before the Can. Soc. of Civ. Engrs. Describes the equipment for lighting and power, which are so liberal as to make navigation at night as easy as by daylight. Discussion. 6200 w. Can Elec News—April, 1904. No. 62360.

Electricity vs. Mule Power on Canals. H. M. Riseley. Illustrated description of an electrical device invented by Stephen W. Wood. 800 w. Sci Am Sup—April 9, 1904. No. 62008.

Dams.

The Cylindrical Movable Dams at Schweinfurt, Germany. A. Steens. Brief illustrated description of a novel type built in a river subject to heavy floods, where a rapid discharge of freshet water was often necessary. 900 w. Sci Am—April 16, 1904. No. 62119.

See also Civil Engineering, Water Supply.

Docks.

The Modern Development of Docks. Brysson Cunningham. Discusses the accommodation for modern ships, recent improvements in docks, etc. Ills. 3500 w. Cassier's Mag—April, 1004. No. 62108 B.

Dredge.

Combination Hydraulic and Dipper Dredge for the Mexican Government. Drawings and particulars of construction furnished by the builders of the dredge

"El Chijol." 2500 w. Eng News—April 21, 1904. No. 62185.

Heysham.

The Heysham Harbour Scheme. Armisted Cay. An illustrated description of the new Midland Railway port, which is nearly completed. 3800 w. Page's Mag—April, 1904. No. 62387 B.

Port.

Proposed Home Shipping Port for Canada. Map and information concerning a scheme to utilize Loch Linnhe, on the west coast of Scotland, stating the advantages. 1300 w. Engr, Lond—March 25, 1904. No. 61939 A.

Reclamation.

Reclamation of the Marshes of New Jersey and Staten Island. Henry Clay Weeks. Explains the present conditions, the value of this land if reclaimed, plans suggested, and a proposed plan of improvement, discussing objections. Map. 3800 w. Eng News—April 7, 1904. No. 61995.

River Improvement.

A Proposed Improvement of the Channel of the Sacramento River. W. L. Huber. Discusses schemes for carrying off the flood water, and reclaiming valuable land. 1200 w. Cal Jour of Tech—April, 1904. No. 61972 C.

Stream Flow.

See Civil Engineering, Measurement.

MISCELLANY.

Land Slide.

A Phenomenal Land Slide. D. D. Clarke. Relates to the slide affecting the reservoirs of Portland, Oregon, describing the surveys and explorations which have been made during the last nine years, for the purpose of determining the dimensions of the slide and its probable cause, and to aid in devising a plan for a cure of the difficulty. Maps, illustrations, etc. 25500 w. Pro Am Soc of Civ Engrs—March, 1904. No. 62323 E.

ELECTRICAL ENGINEERING

COMMUNICATION.

Batteries.

Some Aids in the maintenance of Common-Battery Central Offices. A. Dallam O'Brien. Considers various troubles that annoy and the methods of testing and correcting with promptness. 2000 w. Am Elect'n—April, 1904. No. 61895.

Cable-Laying.

See Marine and Naval Engineering.

Cables.

Recent Submarine Telephone Cables (Ueber Neuere Unterseeische Fernsprechkabel). F. Breisig. Illustrating and describing recent cables laid to connect the North Sea islands with Germany. 5000 w. Elektrotech Zeitschr—March 17, 1904. No. No. 62254 B.

The Localization of Breaks in Submarine Cables. Remarks on reported tests of A. Davidson, concerning the importance of knowing the conditions under which the tests were made. 2500 w. Elec Rev, Lond—April 1, 1904. No. 61943 A.

The Manufacture of Multiple Telephone Cables with Air Insulation. (Die Fabrikation Mehradriger Telephonkabel mit Luftisolation) J. Schmidt. Giving sections of various makes of cables and details of their construction. 3500 w. Zeitschr f Elektrotechnik—April 10, 1904. No. 62267 D.

See also Electrical Engineering, Distribution.

Combination Circuits.

Simultaneous Telephone and Telegraph Equipment. Le Roy W. Stanton. An illustrated article showing the arrangement by the circuit, and the details of the system, and giving information concerning the amount of work already done in the application, and remarks on the effect to be anticipated. 4000 w. Elec Wld & Engr—April 2, 1904. No. 61864.

Exchanges.

Manual vs. Automatic Telephone Exchanges. Howard S. Knowlton. Discusses in detail the disadvantages of the automatic system and the reasons given in its favor. 2200 w. Am Elect'n—April, 1904. No. 61891.

Printing Telegraph.

The Use of Printing Telegraphs in Berlin (Ueber den Ferndruckertrieb in Berlin). Adolf Franke. An extensively illustrated paper describing the workings of the Siemens & Halske system in Berlin. 4000 w. Elektrotech Zeitschr—March 24, 1904. No. 62259 B.

Telegraphy.

Telegraphy in Siberia. L. Lodian. An illustrated article describing the severe conditions which have to be met by the linemen, and the present heavy and responsible work of transmitting war news in cipher. 2000 w. Elec Rev, N. Y.—April 16, 1904. No. 62125.

Telephony.

Telephone Engineering. J. C. Kelsey.

We supply copies of these articles. See page 476.

The first of a series of articles reviewing those circuits that have played a prominent part in the development of the telephonic art, and have at one time been a standard form. The present article considers the series grounded system. 2200 w. Elec Rev, N. Y.—April 9, 1904. Serial. 1st part. No. 62010.

Teletyping.

The Berlin Teletyping Central Station. Dr. Alfred Gradenwitz. Illustrates and describes a type-printing telegraph and its operation. 900 w. Elec Rev, N. Y.—April 9, 1904. No. 62012.

DISTRIBUTION.

Boosters.

Booster Calculations. William A. Del Mar. Considers the various conditions controlling the installation and use of boosters. 3000 w. Elec Wld & Engr—April 9, 1904. No. 62031.

Cables.

The Installation of Electric Cables. H. W. Buck. Discusses general principles and suggests directions in which improvements can be made. Ills. 3000 w. Elec Club Jour—April, 1904. No. 62104.

See also Electrical Engineering, Communication.

Conduits.

Electric Conduit Construction at Memphis, Tenn. F. G. Proutt. Describes work done by day labor, the system, etc., giving costs and particulars. Ills. 8000 w. Eng News—April 14, 1904. No. 62052.

Recent Development in Metal Conduits for Electric Light Installations. L. M. Waterhouse. Reviews the kinds of conduit used, and explains the advantages of metal conduits. 2500 w. Elec Rev, Lond—April 1, 1904. No. 61942 A.

Converters.

Synchronous Converters. F. G. Baum. An explanation of the theory of operation of converters. Gives the characteristic regulation curves of a small polyphase converter when employed as a shunt machine, and when compounded. 3000 w. Elec Wld & Engr—April 9, 1904. No. 62032.

Faults.

Localization of Faults on Low-Tension Networks. W. E. Groves. Read at Birmingham before the Inst. of Elec. Engrs. Remarks referring particularly to a three-wire low-tension network, with the neutral earthed at the generating station or sub-station through a resistance of 2 ohms. 2800 w. Elec Rev, Lond—April 8, 1904. Serial. 1st part. No. 62155 A.

Insulators.

The Inflammability of Rubber Insulating Tape (Ueber die Entflammbarkeit Biegsamer Gummibandschnüre). J. Herzog and C. Feldmann. With diagram giving the results of tests as to the extent to which the conductor may become heated without igniting the insulation. 1000 w. Elektrotech Zeitschr—March 17, 1904. No. 62252 B.

Mains.

Economy in Electric Mains. Discusses the devices and systems aiming at a reduction of cost, with the view of showing their reliability or unreliability. 1500 w. Elec Engr, Lond—April 1, 1904. No. 62-064 A.

Sub-Stations.

Energy Distribution to Sub-Stations. C. Alfred Smith. Abstract of a paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Compares the cost of two different systems. In the first the power is transmitted electrically from a gas engine station and distributed by means of sub-stations; in the second the gas is transmitted to gas-engine sub-stations, other conditions remaining the same. 6000 w. Elec'n, Lond—April 1, 1904. No. 62-067 A.

Wiring.

Electric Wiring of Machine Tools. O. W. Bodler. Shows the way of determining the size of the wire, and forms of wiring. Ills. 1200 w. Ry Mas Mech—April, 1904. No. 61853.

ELECTRO-CHEMISTRY.

Cadmium.

Notes on the Electro-Deposition of Cadmium and Its Alloys. Sherard Cowper-Coles. Reports results of investigations made. 2500 w. Elec-Chem & Met—March, 1904. No. 62322 C.

Electro-Metallurgy.

The Applications of Electricity to Metallurgy. Joseph W. Richards. Classifies the electro-metallurgical processes and explains the principles on which they are based. 6600 w. Tech Qr—March, 1904. No. 62357 E.

Steel.

The Electrical Manufacture of Steel. Gustave Gin. Abridged translation of M. Gustave Gin's description of his latest process for the production of steel by electrical means. 3500 w. Elec-Chem & Met—March, 1904. No. 62321 C.

ELECTRO-PHYSICS.

Distortion.

Distorted Alternating and Rotating Magnetic Fields. R. Goldschmidt. A study of the effect of distorted voltage, illustrating by example. 1200 w. Elec Rev—April 8, 1904. Serial. 1st part. No. 62154 A.

We supply copies of these articles. See page 476.

Eddy Currents.

Eddy Current Losses (Ueber Wirbelstromverluste). F. Niethammer. Deriving working formulas for the computation of losses, with practical applications. 1200 w. Zeitschr f Elektrotechnik—April 3, 1904. No. 62266 D.

Eddy Currents in Cable Sheaths. M. B. Field. Read before the Inst. of Elec. Engrs. A theoretical consideration of the currents induced in cable sheaths and the losses occasioned thereby. 4700 w. Elect'n, Lond—April 15, 1904. Serial. 1st part. No. 62338 A.

Radio-Activity.

The Practical Uses of Radiant Energy. Discusses the theories of light and heat, and their practical applications. 2500 w. Jour Gas Lgt—April 12, 1904. No. 62189 A.

Radio Activity of Certain Minerals and Mineral Waters. R. J. Strutt. Read before the Royal Soc. Gives results of an examination of certain radio-active materials, describing method used. 3000 w. April 1, 1904. No. 62066 A.

Recent Discoveries in Radiation and Their Significance. R. A. Millikan. Reviews recent discoveries of new rays, and their relation to the question of the nature and constitution of matter. 7500 w. Pop Sci M—April, 1904. No. 62084 C.

Radium.

Contributions to Our Knowledge of Radium. W. Marckwald. Trans. from *Berichte der Deutsch. Chem Gesell.* Considers the separation of radium from barium, the phosphorescence of the anhydrous radium-barium chloride, and induced radio-activity. 1200 w. Sci Am Sup—April 23, 1904. No. 62303.

Radium. Translated from the French of Jacques Danne, in *Le Génie Civil.* An account of the discovery and description of methods of research. Ills. 4500 w. Sci Am Sup—April 9, 1904. Serial. 1st part. No. 62007.

The Wonderful New Element, Radium. E. Booth. The substance of a popular lecture delivered at the Univ. of California. 3600 w. Cal Jour of Tech—April, 1904. No. 61974 C.

Shielded Balance.

The Shielded Balance. G. A. Campbell. Aims to show how the source of error when alternating current is employed may be entirely eliminated by shielding. 2500 w. Elec Wld & Engr—April 2, 1904. No. 61867.

Solenoids.

Predetermining Solenoid Characteristics. William A. Del Mar. Considers the design of a solenoid for tractive work, illustrating by examples which show that the gradient formula gives results which agree fairly well with practice. 2000 w. Am Elect'n—April, 1904. No. 61893.

Thermo-Electricity.

Thermo-Electric Forces in a Heated Wire (Thermoelektrische Kräfte in einem Erwärmten Draht). F. Schneider. A review of the experiments of Egg-Sieberg, showing that the origin of the current in a heated wire is the formation of oxide. 1500 w. Elektrotech Zeitschr—March 24, 1904. No. 62258 B.

GENERATING STATIONS.

Alternators.

A Contribution to the Theory of the Regulation of Alternators. H. M. Hobart and F. Punga. Discussion, with formulæ and diagrams. 7500 w. Trans Am Inst of Elec Engrs—April 22, 1904. No. 62187 D.

A General Diagram for Alternators. Gives an explanation of Prof. F. Niethammer's method of pre-determining the characteristics of alternating-current machinery by graphical means, which has been found to give accurate results in practice. 1400 w. Elect'n, Lond—April 15, 1904. No. 62339 A.

The Mechanical Construction of Revolving-Field Alternators. David B. Rushmore. Paper before the Am. Inst. of Elect. Engrs., with illustrations and diagrams. 7700 w. Trans Am Inst of Elec Engrs—April 22, 1904. No. 62186 D.

Economy.

Central-Station Economy. F. H. Davies. Calls attention to many small losses in central-station practice which, if corrected, would aggregate a considerable saving. 3300 w. Elec Engr, Lond—April 15, 1904. No. 62335 A.

Heat Losses.

Joule Heat Losses in a Cage Armature (Verluste durch Joulesche Wärme in einem Käfiganker). F. Punga. Developing formulas for computing the heat losses in armatures of the squirrel-cage type. 1200 w. Zeitschr f Electrotechnik—March 27, 1904. No. 62265 D.

Hydro-Electric.

Hydroelectric Power Plant at Zwolfmalgreien, in Tyrol, Austria. Franz Koster. Illustrated detailed description. 3200 w. Elec Rev, N. Y.—April 2, 1904. No. 61801.

The Atlanta Water & Electric Power Company's Plant at Morgan Falls. Illustrated description of a plant comprising a large masonry dam, a fireproof power-house equipped with horizontal turbines and large alternating current generators, and a high-voltage transmission line. 4500 w. Eng Rec—April 23, 1904. No. 62372.

We supply copies of these articles. See page 476.

The Electric Station at Kubel, near St. Gall (Das Elektrizitätswerk Kubel bei St. Gallen). L. Kürsteiner. A fully illustrated description with details of the dam, canal, and electric generating and distributing plant. Serial. Part I. 1500 w. Schweizerische Bauzeitung—April 2, 1904. No. 62230 D.

The Hydroelectric Station of Champ. Enrico Bignami. Illustrated description of an industrial power station in the province of Isère, erected and operated by local interests. 2500 w. Elec Rev, N. Y.—April 9, 1904. No. 62011.

The Location of Electric Water-Power Stations. Alton D. Adams. Illustrates and describes examples of American practice. 3500 w. Cassier's Mag.—April, 1904. No. 62109 B.

Water Power Transmission Plant at Elliott's Falls, Ontario. Charles L. Fitch. Illustrates and describes the plant which is to furnish power for the Raven Lake Portland Cement Company. 2000 w. Elec Wld & Engr—April 2, 1904. No. 61865.

Inspection.

Inspection of Plants. George A. Burnham. The present paper considers dynamos and connections. The object is to point out the troubles which are liable to occur, and a simple and efficient method of locating and remedying them. Ills. 1600 w. Engr, U S A—April 1, 1904. Serial. 1st part. No. 61859 C.

Port Huron.

Steam Turbine and Other Features of the Port Huron Light and Power Company's Station. James E. Davidson. An illustrated description of this company's installation of the Curtis steam turbine, with a review of the general conditions of the station. 6500 w. Elec Wld & Engr—April 9, 1904. No. 62030.

Ship Equipment.

See Marine and Naval Engineering.

West Ham.

New Electricity Works at West Ham. Illustrated description of this new electric generating station which is one of the largest English municipal undertakings. 3500 w. Elect'n, Lond—April 1, 1904. No. 62065 A.

Windings.

The Production of Pure Sine Currents (Ueber die Erzeugung Reiner Sinusströme). Reinhold Rüdenberg. Discussing methods of winding by which an exact sine curve may be produced when such is desired. 2500 w. Elektrotech Zeitschr—March 31, 1904. No. 62261 B.

LIGHTING.

Arcs.

A Contribution to the Study of the Electrical Arc. Dr. William S. Weedon. Read at Washington meeting of the Am. Elec. Chem. Soc. Considers only direct-current arcs. A report of experimental investigations. 4000 w. Elec Rev, N. Y.—April 23, 1904. No. 62370.

Improvements in Electric Arc Street Lighting. H. W. Hillman. From a paper read before the Am. Soc. of Munic. Imp. Illustrated descriptions of recent work, showing the great improvement in appearance. 1500 w. Munic Engng—April, 1904. No. 62088 C.

Chronophotography.

The Application of the Electric Spark to the Chronophotography of Rapid Movements (Application de l'Etincelle Electrique à la Chronophotographie des Mouvements Rapides). Lucien Bull. Describing an apparatus for enabling cinematograph photographs to be taken at very close intervals of time. 1000 w. Comptes Rendus—March 21, 1904. No. 62228 D.

Electricity vs. Gas.

New Lamps for Old. R. J. Milbourne. Reviews the progress of electricity, and gives a comparison of costs in favor of gas. 3300 w. Jour Gas Lgt—April 12, 1904. No. 62191 A.

Photometry.

The Various Methods of Measuring Illumination (Die Verschiedenen Methoden der Helligkeitsprüfung). A. Wingen. A description of the various scientific and practical methods of measuring the intensities of artificial lights. 4500 w. Gesundheits-Ingenieur—April 10, 1904. No. 62245 D.

See also Gas Works Engineering.

MEASUREMENT.

Condensers.

The Application of Condensers in the Measurement of Alternating Current (Ueber die Verwendung von Kondensatoren bei Wechselstrommessungen). W. Peukert. Discussing the use of condensers for lowering the voltage in high-tension measurements. 2000 w. Elektrotech Zeitschr—March 24, 1904. No. 62256 B.

Diagrams.

Diagrams for the Compensated Series Motor (Diagramme für den Kompensierten Serienmotor). M. Osnos. Developing graphical diagrams for determing the voltage relations at various speeds. 4500 w. Elektrotech Zeitschr—March 17, 1904. No. 62251 B.

The Cascade Diagram for Speeds above Synchronism (Das Kaskadendiagramm für Uebersynchronismus). Paul Müller. Discussing the modifications necessary in the circle diagram for induction motors operated in cascade when the speed is above

synchronism. 1800 w. Elektrotech Zeitschr—March 24, 1904. No. 62257 B.

Efficiency Determination.

Finding Dynamo Efficiency by the Electrical Method. F. C. Caldwell. Describes methods of determining the various classes of losses. 2800 w. Engr, U S A—April 1, 1904. No. 61858 C.

The Efficiency Curves of Constant-Potential Transformers. A. E. Kennelly. A treatment of this subject stating the assumption made and concluding the efficiency curve is an acute hyperbola, having for one of its asymptotes a straight line representing only the copper loss. 1200 w. Elec Wld & Engr—April 16, 1904. No. 62141.

Errors.

The Errors of Instruments. George T. Hanchett. Showing that a recording wattmeter is subject to errors of voltage, and cannot be used on any voltage promiscuously. 1200 w. Cent Sta—April, 1904. No. 62013.

Galvanometers.

Electrical Measuring Instruments. S. S. Edmonds. The present article illustrates and describes three types of galvanometer. 2200 w. Engr, U S A—April 15, 1904. Serial. 1st part. No. 62137 C.

Measuring Instruments.

Direct Reading Measuring Instruments for Switchboard Use. Kenelm Edgecombe and Franklin Punga. Abstract of a paper read before the Inst. of Elec. Engrs. Describes the chief types of switchboard measuring instruments and the electrical errors. 5000 w. Elect'n, Lond—March 25, 1904. Serial. 1st part. No. 61932 A.

Meters.

A Phase Meter (Ein Phasenmesser). A. Grau. Describing an arrangement of an alternating-current wattmeter so that it will indicate the power factor and enable the difference of phase to be found. 1000 w. Elektrotech Zeitschr—March 31, 1904. No. 62260 B.

Motor Testing.

A Test for Induction Motor Windings. G. H. Garcelon. Describes a test based upon the fact that any error in the winding will destroy the symmetry of the magnetic field produced by the winding when single-phase alternating-current is passed through it. Ills. 2200 w. Elec Club Jour—April, 1904. No. 62106.

Dynamo and Motor Testing. C. F. Smith. Abstract of a paper read before the Civil and Mech. Engrs. Soc. Deals with the equipment of a test house, and methods of testing. 2200 w. Prac Engr—April 8, 1904. No. 62164 A.

Tests of Motor Driven Roller Tables at Duquesne. Albert Kingsbury. Describes tests made to determine data for use in estimating the sizes of motors required in this class of service. 3000 w. Ir Age—March 31, 1904. No. 61823.

Notation.

A System of Fundamental Notation (Einheitliche Formelzeichen). K. Strecker. Suggestions for a general system of fundamental notation of physical quantities. 10,000 w. Elektrotech Zeitschr—March 31, 1904. No. 62262 B.

Ondograph.

The Hospitalier Ondograph. Illustrated description of this instrument for tracing directly the wave forms of variable currents. 1200 w. Sci Am Sup—April 23, 1904. No. 62301.

Power Curves.

Theoretical Determination of Power Curves. Gives communications from V. R. Heftler, John C. Parker, Bassett Jones, Jr., and Frank R. Stowe, having for their subject the article by W. J. Berry, which appeared in the issue of Jan. 30. 1000 w. Elec Wld & Engr—April 16, 1904. No. 62142.

Timing.

Electric Timing Arrangement on the "Cresta" at St. Moritz. An illustrated description of the apparatus for timing the racing on this celebrated toboggan run. 1100 w. Elec Rev, Lond—April 1, 1904. No. 61941 A.

New Electric Chronometer for Timing Automobiles. Illustrates and describes an ingenious electric apparatus and its operation. 900 w. Sci Am—April 23, 1904. No. 62197.

MOTORS.

Canal Traction.

See Civil Engineering, Waterways.

Design.

Construction of a 2-H. P. Motor or 25-Light Incandescent Dynamo. F. C. Mason. Drawings with explanatory notes. 2500 w. Am Elect'n—April, 1904. No. 61894.

Driving.

The Adaptability of Electrical Driving. B. Longbottom. Abstract of a paper read before the Manchester Assn. of Engrs. Considers the mechanical forms of power distribution, giving tabulated results of tests, and furnishing means of comparison between mechanical and electrical distribution, and information concerning the advantages. 3000 w. Elect'n, Lond—April 8, 1904. No. 62157 A.

See Mechanical Engineering, Machine Works and Foundries.

Dynamos.

Design of Small Dynamos. J. W. Burleigh. Illustrates the course adopted by the writer, giving briefly the principal formulæ used in determining the results. 1000 w. Elec Rev, Lond—April 8, 1904. No. 62156 A.

Induction Motors.

The Induction Motor. Explains the principle of the induction motor, its operations, with diagrams and illustrated descriptions of some forms. 9500 w. Harvard Engng Jour—April, 1904. Serial. 1st part. No. 62391 D.

Mining Plant.

See Mining and Metallurgy, Mining.

Motor Testing.

See Electrical Engineering, Measurement.

Rolling Mills.

See Mining and Metallurgy, Iron and Steel.

Single-Phase.

Single Phase Commutator Motors (Die Einphasigen Kommutatormotoren). J. K. Sumec. An elaborate mathematical study, employing both analytical and graphical methods. Serial. Part I. Zeitschr f Elektrotechnik—March 20, 1904. No. 62264 D.

Single-Phase Motors as a Means of Increasing Station Earnings. W. A. Layman. Presented at meeting of the Ohio, Colorado, and Southwestern Electric Light Assn. Shows ways in which the single-phase, alternating-current motor lends itself to power distribution and economical service. Describes the Wagner single-phase motor. Ills. 3000 w. Jour of Elec —April, 1904. No. 62149 C.

The Westinghouse Single-Phase Motor. Illustrated description of this alternating-current series motor. It is claimed that by a simple change in the controller the motor can be operated by direct current. 1100 w. R R Gaz—April 8, 1904. No. 62002.

Variable Speed.

Variable Speed Motors. J. W. Burleigh. Shows the writer's method of design of motors capable of withstanding large variations of speed. 900 w. Elec Rev, Lond—March 25, 1904. No. 61931 A.

Variable Speed Motors. William Baxter, Jr. Illustrated description of types made by the General Electric Co. 2500 w. Mach, N. Y.—April, 1904. Serial. 1st part. No. 61811 C.

TRANSMISSION.

High Voltage.

Some Problems in Electrical Engineering Due to the Conductivity of the Atmosphere. Harris J. Ryan. An analysis of the factors that produce the energy losses through the atmosphere in high-voltage lines. 5000 w. Sib Jour of Engng—April, 1904. No. 62307 C.

Long Span.

A Long-Span Transmission Line. B. Wiley. Describes a power line from the Carrie furnaces to the Homestead Steel Works, the particular feature being a span of 1000 feet between supports. Ills. 1300 w. Elec Wld & Engr—April 16, 1904. No. 62140.

MISCELLANY.

Laboratory.

The Laboratoire Central D'Electricité at Paris. Albert Campbell. A description of some of the things seen in the main public laboratory for electrical testing work. 1200 w. Elec Rev, Lond—March 25, 1904. No. 61929 A.

Law.

Electricity and the Law in England and America. W. Valentine Ball. A comparison of the two countries as regards liabilities of supply companies. 3400 w. Elec Wld & Engr—April 2, 1904. No. 61866.

Loft Buildings.

Loft-Buildings—Electric Power Desirable. E. R. Knowles. States the conditions in large cities which have led to the growth of the modern loft building, its requirements, etc. 1500 w. Elec Rev, N. Y.—April 2, 1904. No. 61802.

GAS WORKS ENGINEERING

Brentwood.

The Brentwood Gas-Works: As They Were and as They Are. Illustrated detailed description. 4500 w. Jour Gas Lgt —April 12, 1904. No. 62190 A.

Business Practice.

Gas Engineering. W. A. Baehr. A lecture before the students of the Univ. of Wis. Describes the engineering features of the business, the manufacture and distribution. 8000 w. Wis Engr—April, 1904. No. 62094 D.

Chemistry.

A Brief Outline of Gas-Works Chemistry. H. B. Harrop. Read at meeting of Wis. Gas Assn. An outline of a desirable

We supply copies of these articles. See page 476.

course, intended to give practical help to gas-workers. 12500 w. Pro Age—April 1, 1904. No. 61799.

Meters.

Care of Station Meters. Henry R. Cartwright. Gives details of the care needed. Short discussion. 2000 w. Pro Age—April 15, 1904. No. 62083.

Mixed Gas.

Besemfelder's Mixed-Gas Process. Abstract translation of a paper by the inventor giving particulars of the advantages of this process for a continuous production of a mixed gas of uniform composition. 3000 w. Jour Gas Lgt—April 12, 1904. No. 62192 A.

Outputs.

Why English Gas Outputs Are Large, with Lessons to Be Drawn in the United States. J. T. Westcott. Tabulated information concerning representative towns in different countries, with explanation of conditions in England. General discussion. 3300 w. Pro Age—April 15, 1904. No. 62082.

Photometry.

Flicker Photometry in Its Relation to Sources of Light of Different Colors. Dr. Hugo Krüss. Summary of an address to the Lower Saxon Assn. An account of investigation, with the author's conclusions. 2300 w. Gas Wld—March 26, 1904. No. 61927 A.

See also Electrical Engineering, Illumination.

Progress.

Progress Department Report, at Meeting of Ohio Gas Light Association. Irvin Butterworth. A résumé of the more important technical and mechanical improvements that have been made in gas manufacture, distribution and consumption during the last year. Short discussion. 9500 w. Am Gas Lgt Jour—April 25, 1904. No. 62362.

Purification.

Economy in Oxide Purification. H. L. Rice. Read before the Ohio Gas Lgt. Assn. Calls attention to results achieved under rather unusual conditions at the Norfolk (Va.) works. 5300 w. Am Gas Lgt Jour—April 11, 1904. No. 62027.

Purifying Materials and Spent Oxide. P. Parrish. Considers oxides of iron and spent oxide as purifying materials for coal gas. General discussion. 7000 w. Gas Wld—April 2, 1904. No. 62057 A.

Purifiers.

A New Development in Purifier Grids. F. D. Marshall. Illustrates and describes the "Standard" grid, reviewing investigations that led to its development. 2000 w. Gas Wld—April 2, 1904. No. 62059 A.

Small Plant.

Design of a Small Coal Gas Plant. Alfred G. Lloyd. Read at meeting of Wis. Gas Assn. Considers plants serving 10,000 people or less. Ills. 3500 w. Pro Age—April 1, 1904. No. 61798.

Street Lighting.

The Use of High Pressure Gas on Street Lighting. J. J. Knight. Read before the Ohio Gas Lgt. Assn. Comments on the best means of street lighting now available, with a report of the writer's views on high-pressure service. Also general discussion. 3500 w. Am Gas Lgt Jour—April 11, 1904. No. 62026.

Sulphur.

Sulphur Purification. O. W. Dougan. Abstract of a paper read before the Junior Gas Assn. Discusses the theory and practice, testing, etc. 4000 w. Gas Wld—April 2, 1904. No. 62058 A.

INDUSTRIAL ECONOMY

Apprentices.

What Manchester is Doing for Engineering Apprentices. F. Brocklehurst. An account of the work which is being done in the great electrical and mechanical trade school at Manchester. 3000 w. Engineering Magazine—May, 1904. No. 62276 B.

Contracts.

Uncompleted Works. Discusses questions in English law affecting contracts. 1800 w. Elec Rev, Lond—April 1, 1904. No. 61944 A.

Cost Keeping.

Cost Keeping and Shop Statistics for a Repair Shop. A. W. Thompson. Describing the working of a practical system in the repair shops attached to a large mill corporation and well adapted for recording a varied line of work. 3000 w. Engineering Magazine—May, 1904. No. 62273 B.

Education.

Resumed Discussion on Mr. Max Wurl's Paper on "Technical Education in Germany." Plate. 11000 w. Trans N-E Coast Inst of Engrs & Shipbuilders—March, 1904. No. 62318 D.

The Technical Graduate and the Machinery Department of Railroads. W. F. M. Goss. Outlines the development of the

We supply copies of these articles. See page 476.

technical graduate, his training, etc., and considers some of the defects in the administration of special apprenticeship, and the remedy. General discussion. 12500 w. Pro W. Ry Club—March 15, 1904. No. 62101 C.

Foreign Trade.

A Comparison of American and European Commercial Conditions. W. J. Clark. A discussion of the economic and industrial factors affecting trade with the United States and other parts of the world. 4000 w. Engineering Magazine—May, 1904. No. 62270 B.

Germany.

The Industrial Advance of Germany. Joseph Horner. An English view of the causes and effects, facts and features. 7000 w. Cassier's Mag—April, 1904. No. 62110 B.

Labor.

Equitable Labor Compensation and Maximum Output. H. L. Gantt. Describes the principles on which the bonus system is founded, and the way in which it is carried out. 3500 w. Cassier's Mag—April, 1904. No. 62111 B.

Exact Time Study as the Basis of Pay for Work Done. H. L. Gantt. Read at the Philadelphia meeting of the Nat. Metal Trades Assn. A discussion of the difficulties in satisfactorily adjusting the price of labor, and the effect on the output of plants. 2800 w. Ir Trd Rev—March 31, 1904. No. 61800.

The Industrial Army of the United States. James Dredge. The present article gives information based on the U. S. census, in regard to the population and its distribution, the extent of territory, etc. 4000 w. Trac & Trans—April, 1904. Serial. 1st part. No. 62079 E.

Organization.

The Employers' Association of the Future. Henry M. Leland. Prepared for the Nat. Metal Trds. Assn. A discussion of the attitude of labor and capital and the future outlook, with suggestions as to the steps needed. 4500 w. Ir Trd Rev—April 7, 1904. No. 61985.

Specifications.

A Schedule of General Clauses to Be Used as a Guide in Drawing Specifications. 3000 w. Eng News—April 21, 1904. No. 62178.

Steel Trust.

The German Steel Trust (Der Deutsche Stahlwerksverband). An editorial note giving the list of firms forming the combination of steel makers in Germany, with an abstract of the articles of their agreement. 1500 w. Stahl u Eisen—March 15, 1904. No. 62215 D.

Stock Tracing.

Card Systems and Diagrams—Keeping Track of Stock—Factory Management. J. S. V. Bickford. An interesting discussion of the topics named. 2200 w. Am Mach—April 14, 1904. No. 62042.

Subsidies.

Merchant Cruisers and Steamship Subsidies. Lord Brassey. Read before the Inst. of Naval Archts. Urges a more liberal expenditure on subsidies to fast ocean services. 1500 w. Engng—April 1, 1904. No. 62075 A.

Wage Methods.

Wage Paying Methods from the Viewpoint of the Employer. Henry Hess. Mr. Hess's second paper examines the wage problem from the employer's side of the question, illustrating the results of various plans by the graphical method. 3000 w. Engineering Magazine—May, 1904. No. 62271 B.

MARINE AND NAVAL ENGINEERING

Battleships.

A New Japanese Battleship. Particulars of a vessel now building at Elswick Shipyard for the Imperial Japanese Navy. Ills. 3800 w. Engr, Lond—April 8, 1904. No. 62162 A.

The Battleships "Triumph" and "Swiftsure," late "Libertad" and "Constitution." Sir Edward J. Reed. Read at the Inst. of Naval Archts. Explains the steps that led to the construction of these ships, giving particulars, and describing design, armament, etc. 5000 w. Engng—March 25, 1904. No. 61936 A.

Bulkheads.

Longitudinal Engine-Room Bulkheads in Merchant Vessels, in Relation to Transverse Stability When Bilged. F. H. Alexander. Read before the N. E. Coast Inst. of Engrs. and Shipbuilders. The object of the paper is to show the possible effect on the transverse stability of a ship, if one side of the engine space were flooded. Ills. 3000 w. Prac Engr—April 8, 1904. No. 62163 A.

Cable Laying.

The Twin-Screw Cable-Laying Steamer "Stephan." An illustrated detailed de-

We supply copies of these articles. See page 476.

scription of the second German cable steamer. 2800 w. Engng—March 25, 1904. Serial. 1st part. No. 61935 A.

Car Ferry.

Pere Marquette 19: A Car Ferry of the Largest Size. Illustrated detailed description. 1000 w. Marine Engng—April, 1904. No. 61818 C.

The Danish Steam Car Ferry "Prins Christian." Illustrates and describes a vessel built to complete the new direct route between Berlin and Copenhagen. 1300 w. Marine Engng—April, 1904. No. 61817 C.

Colliers.

Steam Colliers. Reviews the development of the cargo steamer from the steam colliers employed in coasting and cross-channel work. 2500 w. Col Guard—April 1, 1904. No. 62068 A.

Electrical Equipment.

The New White Star Steamer Baltic's Electrical Equipment. George E. Walsh. Describes some of the electrical devices of this vessel, which has the most extensive electrical equipment yet installed. 1300 w. Elec Rev, N. Y.—April 16, 1904. No. 62124.

Experimental Tanks.

A National Experimental Tank. Sir William H. White. Read before the Inst. of Naval Archts. A proposal for the establishment of a national experimental tank, to be chiefly devoted to research work in connection with fluid resistance and ship-propulsion. 6500 w. Engng—April 1, 1904. No. 62073 A.

Some Results of Model Experiments. R. E. Froude. Describes a series of resistance experiments on systematic variations in form of hull, giving results. 4200 w. Engng—April 1, 1904. No. 62071 A.

Ferryboats.

New Screw Ferryboats. Illustrated detailed description of craft designed for use by the City of New York for the Staten Island ferry. 3800 w. Naut Gaz—March 31, 1904. Serial. 1st part. No. 61870.

Hull Protection.

Ships' Compositions. A. C. A. Holzapfel. Read before the Inst. of Naval Archts. Discusses the large number of compositions for the protection of ships, details of their manufacture, and the chemical processes upon which their efficacy depends, and other attempts at protecting vessels. 3800 w. Engng—April 8, 1904. Serial. 1st part. No. 62161 A.

Japanese Navy.

Engineering in the Japanese Navy. Engineer-Rear-Admiral Miyabara. Read before the Japanese Soc. of Naval Archts. Translated by Prof. S. Terano. Outline description of recent developments of marine engineering in the Japanese navy, with special reference to Miyabara's patent water-tube boiler. Ills. 4300 w. Engng—April 15, 1904. No. 62354 A.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Motor Boats.

Gas and Oil Engines for Marine Propulsion. John E. Thornycroft. Read at meeting of the Inst. of Nav. Archts. Considers the different systems and the way in which they work. Ills. 2300 w. Mech Engr—April 2, 1904. No. 62060 A.

Gasoline Engines for Fast Boats. Herbert L. Towle. Discusses the principles governing the construction of the high-power launch, and problems related. 2000 w. Am Mach—April 21, 1904. No. 62168.

Motor Boat Races in France. Remarks on the races at Monaco Bay, with illustrations of boats. 1500 w. Engr, Lond—April 15, 1904. No. 62345 A.

1904 Rating of French Motor Boats. A résumé of rules controlling motor boat-racing in French waters. 1000 w. Auto Jour—March 26, 1904. No. 61922 A.

Oscillations.

The Gyroscopic Effect of Flywheels on Board Ships. Herr Otto Schlick. Read before the Inst. of Naval Archts. Describes an appliance, proposed by the writer, the employment of which makes it possible not only to increase the period of oscillation of a vessel, but also to lessen her angle of heel. It depends in principle on the gyroscopic action of a rapidly rotating flywheel. Ills. 5300 w. Engng—April 1, 1904. No. 62074 A.

Propellers.

An Inquiry Regarding the Marine Propeller. J. Millen Adam. Continued discussion. 2000 w. Trans Inst. of Engrs. & Shipbuilders of Scotland—Feb. 23, 1904. No. 62316 D.

Marine Propellers with Non-Reversible Engines and Internal Combustion Engines. Rankin Kennedy. Discussion of this paper. 3400 w. Trans Inst of Engrs & Shipbuilders of Scotland—Feb. 23, 1904. No. 62315 D.

Propulsion.

The Problem of Screw Propulsion. Arthur Rigg. An explanation of the writer's theory concerning screw propulsion, and giving an account of tests which led to it. 2500 w. Engr, Lond—April 15, 1904. Serial. 1st part. No. 62343 A.

Rolling.

The Theory of the Schlick Cycle (Die Theorie des Schlickschen Schiffskreisels).

A. Föppl. An examination into the theory of Otto Schlick concerning the periodical effect in the rolling of ships. 4500 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62205 D.

Rudder Pressures.

The Normal Pressures on Thin Moving Plates. A. W. Johns. Abstract of paper read before the Inst. of Naval Archts. Gives results of experimental investigations in air and in water. 2000 w. Engr, Lond—April 15, 1904. No. 62350 A.

Stability.

Notes on the Construction of Stability Cross Curves from Balanced Paper Sections. John H. Heck. An explanation of methods of calculating the stability of ships. Short discussion. 5 plates. 4200 w. Trans N E Coast Inst of Engrs and Shipbuilders—March, 1904. No. 62319 D.

Steamer.

New Steamer for the Coast Survey. Illustrated description of a new single-screw steamer designed for the requirements of the duty. 500 w. Marine Rev—March 31, 1904. No. 61868.

New Steamship Mongolia, for the Pacific Mail Steamship Company. Illustrated description of a recently completed vessel. 6000 w. Marine Engng—April, 1904. No. 61815 C.

The Twin Screw Freight and Passenger Steamship "Gnesenau" (Der Doppelschrauben Fracht und Passagierdampfer "Gneisenau"). Hermann Hildebrandt. A very complete description of a new 15,000-ton vessel of the North German Lloyds. 5000 w. 3 plates. Zeitschr d Ver Deutscher Ing—April 9, 1904. No. 62208 D.

Submarine Mines.

The Submarine Mine. Describes the three different kinds of submarine mines, giving illustrations showing the principles upon which they are built and operated. 1500 w. Sci Am—April 23, 1904. No. 62199.

Torpedoes.

The Torpedo in Warfare. Herbert C. Fyfe. An illustrated article giving the history of the "Whitehead" torpedo. 2200 w. Engng Times—March, 1904. No. 62-384 B.

Turbine Propulsion.

Steam Turbines for High-Speed Cunarders. Editorial on the decision of the Cunard Company to adopt steam turbines on their two new high-speed liners. 2000 w. Engng—April 1, 1904. No. 62072 A.

Steam Turbine Propulsion for Marine Purposes. Prof. A. Rateau. Considers the principal difficulties in applying turbines to the propulsion of ships, and the details of the two applications made of the Rateau steam turbines. 5700 w. Mech Engr—April 2, 1904. No. 62061 A.

See also Mechanical Engineering, Steam Engineering.

Unsinkable Vessels.

A New Invention for Rendering Vessels Unsinkable. Herbert C. Fyfe. Illustrates and describes the new Stone-Lloyd hydraulically-controlled marine safety bulkhead doors for rendering vessels unsinkable as installed on the "Deutschland," and their method of working. 2500 w. Sci Am Sup—April 16, 1904. No. 62123.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Alcohol as a Motive Power. W. R. Ormandy. Arguments showing alcohol to be a suitable motor fuel, and in some respects the most suitable fuel, and giving proofs of its practical possibilities. 5000 w. Motor Car Jour—April 2, 1904. No. 62054 A.

Clutches.

Friction Clutches on Automobiles. Reproduction from the *Horseless Age* of a translation from *La France Automobile*, giving a review of French practice in this feature of automobile design. Ills. 3000 w. Mech Engr—April 9, 1904. Serial. 1st part. No. 62153 A.

Exhibition.

Agricultural Hall Show. A review of the principal novelties, aiming to describe particularly things not previously exhibited or described. Ills. 10300 w. Autocar—March 26, 1904. Serial. 1st part. No. 61923 A.

Fire Engines.

Automobile Fire Engines. Emile Guarini. Illustrates some foreign engines, describing a recent engine for the fire department of Paris. 1100 w. Sci Am Sup—April 16, 1904. No. 62121.

Highway Law.

The Use of the Highway. A. Moresby White. Read at the British Auto. Club. A résumé of English law as affecting highways, and the rights of road users. 1700 w. Auto Jour—March 26, 1904. Serial. 1st part. No. 61899 A.

We supply copies of these articles. See page 476.

Motor Car.

The Wolseley Light Six-Horse-Power Motor Car. Illustrated detailed description. 1500 w. Engng—April 1, 1904. No. 62070 A.

Operating Costs.

Some Data on the Cost of Operating Automobiles for Commercial Purposes. Hiram Percy Maxim. Read before the Auto. Club of America. Tests of electric, gasoline, steam and gasoline-electric vehicles, giving much valuable information regarding storage battery maintenance and its cost. 4500 w. Sci Am Sup—April 23, 1904. Serial. 1st part. No. 62302.

Paraffin.

A Successful Paraffin Motor. An illustrated description of an internal combustion motor using paraffin oil as fuel and running without smoke or smell. 1500 w. Autocar—April 16, 1904. Serial. 1st part. No. 62329 A.

Petrol Cars.

The 4-Cylinder 15-20-H. P. Brooke Petrol Car. Begins an illustrated detailed description of this car, which is on exhibition at Agricultural Hall. 1700 w. Auto Jour—March 26, 1904. Serial. 1st part. No. 61898 A.

The 20-H. P. Hutton Petrol Car. An illustrated detailed description of a high-class car having many novel features. It is of English manufacture. 4200 w. Auto Jour—March 26, 1904. Serial. 1st part. No. 61897 A.

The Wilson-Pilcher Petrol Cars. Enumerates the chief special features of these cars, and considers constructional details. Ills. 4000 w. Auto Jour—April 16, 1904. Serial. 1st part. No. 62330 A.

Road Trains.

The Renard Automobile Road Trains. An illustrated detailed description. 900 w. Automobile—April 9, 1904. No. 62009.

Steam Car.

The White Steam Car. Begins an illustrated detailed description of a vehicle which can be driven 100 miles without replenishment of fuel or water. 1200 w. Autocar—April 9, 1904. Serial. 1st part. No. 62150 A.

Tires.

Anti-Skid and Puncture-Proof Bands and Envelopes for Pneumatic Tires. Illustrates and briefly describes some of the devices tested recently in France. 900 w. Sci Am Sup—April 2, 1904. No. 61861.

Tinning.

See Electrical Eng'ng. Measurement.

Turbo-Electric.

A Turbo-Electric Wagon. From the *Horseless Age*. Illustrates and describes a novel design of motor wagon propelled by means of a steam turbine and electric motors. 1400 w. Mech Engr—Feb. 20, 1904. No. 61699 A.

HEATING AND COOLING.

Exhaust Steam.

Two Suggestions for Exhaust Steam Heating. William E. Wood. Suggestions intended for engineers in charge of power houses of moderate size, who are called upon to heat certain spaces in the most economical manner. 1000 w. Eng News—April 7, 1904. No. 61994.

Car Refrigeration.

Mechanical Refrigeration of Freight Cars. Warren H. Miller. States some of the severe requirements of car refrigeration and describes the Miller system. Ills. 2200 w. Stevens Ind—April, 1904. No. 62320 D.

Cold Storage.

Cold Storage by Cold Air Circulation. Illustrated description of E. M. Upton's plant at Rochester, N. Y., where the American Linde Air Circulation system is installed. 3800 w. Ice & Refrig—April, 1904. No. 61878 C.

Combined System.

Combined Steam and Hot Water Radiation. Describes a system installed in a twelve-story office structure in Providence. 1400 w. Eng Rec—April 9, 1904. No. 62022.

Hot Water.

A Graphical Method of Proportioning Pipes for Hot-Water Heating (Graphische Methode der Rohrbestimmung für Wasserheizung). W. Scheer. An examination of the proportions of hot-water heating pipes, with complete charts applicable to any case, together with practical examples of their application. 7000 w. 2 plates. Gesundheits-Ingenieur—March 20, 1904. No. 62244 D.

HYDRAULICS.

Air Lift.

The Direct Elevation of Liquids by Compressed Air (Elévation Directe des Liquides par l'Air Comprimé). E. Lemaire. Illustrating various devices, including the air lift of Siemens, Laurend, and Pöhle, as well as the suctions systems of Jandin and Borsig, and the pressure elevator of Kestner. 2500 w. Génie Civil—March 19, 1904. No. 62212 D.

Flow.

Discharging Capacity of Culverts. Washington Parker Ireland. Reviews the theoretical explanation of the flow of water through pipes, and investigates the flow through large pipes. Ills. 2000 w. Eng Rec—April 2, 1904. No. 61805.

We supply copies of these articles. See page 476.

Hydraulic Machinery.

Hydraulic Power Appliances in the Engineering Industries. George H. Baxter. Mr. Baxter's second paper is devoted to the application of hydraulic power to the operation of wharf cranes, capstans, and auxiliary machinery. 2500 w. Engineering Magazine—May, 1904. No. 62272 B.

Pitot Tubes.

Pitot Tubes: With Experimental Determinations of the Form and Velocity of Jets. James E. Boyd and Horace Judd. Read before the Am. Assn. for the Adv. of Science. An account of experimental investigations with results. 4400 w. Eng News—March 31, 1904. No. 61848.

Pumping Engines.

Improvements in Economy of Pumping Engines. F. W. Dean. Discusses methods of superheating, and the use of superheaters as a means of promoting economy. 2500 w. Jour New Eng W. Works Assn —March, 1904. No. 62096 F.

Pumps.

Improved Pumps (Neue Pumpen). Illustrated description of the Steuer express pump, showing its arrangement for underground service with electric driving. 1800 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62206 D.

Pumps and Pumping Machinery. G. A. F. Ahlberg. Considers general rules in designing pumps, different types, duty and efficiency, etc. Pro Engrs' Soc of W. Penn Jan., 1904. No. 62306 D.

Test of Centrifugal Pump. P. P. Bird. Description and illustrations of the method recently used in testing a pump for the armored cruiser "West Virginia." 1300 w. Marine Engng—April, 1904. No. 61816 C.

The Pumps at the Aussig Industrial Exposition, 1903 (Die Pumpwerke auf der Deutschen Gewerbe und Industrieausstellung in Aussig, 1903). Alexander Fieber. Illustrating especially recent German designs of high-speed pumps. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 19, 1904. No. 62233 D.

Turbine Pumps.

High-Pressure Multi-Stage Turbine Pumps with Special Balancing Device. Illustrated description. 1500 w. Eng News —April 7, 1904. No. 61992.

INTERNAL-COMBUSTION MOTORS.

Alcohol.

See Mechanical Engineering, Automobiles.

Fire Boat.

A Petrol Motor Fire Boat. Brief illustrated description. 500 w. Auto Jour—April 2, 1904. No. 62056 A.

Gas Engines.

Gas Engine Design Constants and Formulas. Sandford A. Moss. Gives tabulated data, the result of an investigation of gas-engine properties begun by the Dept. of Mach. Design, Cornell Univ., with explanations of formulas derived. 2500 w. Am Mach—April 14, 1904. No. 62043.

Small Gas Engines v. Electric Motors. H. E. M. Kensit. Gives tabulated particulars of the cost of operating a number of small gas engines used in various trades, showing a large saving in favor of electric motors for intermittent loads. 800 w. Elec Rev, Lond—April 15, 1904. No. 62337 A.

The Blaisdell Tandem Gas Engine. Illustrates and describes a new heavy duty tandem type recently brought out. 1200 w. Ir Age—April 14, 1904. No. 62038.

The Gas Engine for Central Station Service. Ralph D. Mershon. Read before the N. Y. Elec. Soc. Considers methods of operating, governing, etc.; also cost. 4500 w. Engr, U S A—April 1, 1904. No. 61856 C.

The Gas Engine from the Manager's Standpoint. H. W. True. Read before the New England Assn. of Gas Engrs. Discusses the fuels and their cost for gas engines, their most profitable uses, reliability, and the methods that should be pursued by gas companies to have manufactured gas used, etc. General discussion. 9000 w. Am Gas Lgt Jour—April 11, 1904. No. 62025.

The Nurnberg Gas Engine. Illustrated description of an American-built engine of foreign design. 2000 w. Power—April, 1904. No. 61825 C.

Paraffin.

See Mechanical Engineering, Automobiles.

Valves.

Valves and Valve Mechanism of Internal Combustion Engines. R. E. Phillips. Excerpt of a paper read before the Auto. Club. Remarks confined to the valves and valve mechanisms used in the Otto four-cycle type. Ills. 3700 w. Prac Engr—April 15, 1904. No. 62331 A.

MACHINE WORKS AND FOUNDRIES.

Automobile Works.

The Napier Motor Car Works. Illustrated description of the works at Acton. 1400 w. Engng—April 8, 1904. No. 62160 A.

Castings.

Clearance Allowances in Rough Castings. Joseph Horner. Discusses methods, giving helpful suggestions. Ills. 2200 w. Am Mach—April 14, 1904. No. 62044.

Cost Keeping.

See Industrial Economy.

We supply copies of these articles. See page 476.

Cranes.

Recent Installations of Electric Cranes (Neue Ausführungen Elektrischer Krane). Richard Kann. With illustrations of methods of wiring and operating, together with numerous examples of recent designs and installations. Two articles. 5000 w. Zeitschr f Elektrotechnik—March 20, 27, 1904. No. 62263 each D.

Crank Pins.

Crankpin Bearing. C. H. Bierbaum. Remarks on the conditions and performance of a crankpin bearing with explanation. Ills. 1400 w. Engr, U S A—April 1, 1904. No. 61855 C.

Cranks

Oblique Type Crank Axles. Gives a stress diagram and explains the method of calculating graphically the stresses for the design of its proportions. 600 w. Engr, Lond—April 15, 1904. No. 62348 A.

Dies.

A Combination Cutting, Drawing and Two-Hole Perforating Die. Jack Markx. Illustrated detailed description. 800 w. Am. Mach—April 7, 1904. No. 61962.

Hardening Drop Dies. E. R. Markham. Suggestions for this work, showing that methods must vary according to the stock in the die, its size and outline, the work it must do, etc. 1100 w. Am Mach—April 7, 1904. No. 61968.

Drop Hammers.

The Ambler Drop Hammer. Illustrated description. 600 w. Am. Mach—April 14, 1904. No. 62045.

Electrical Driving.

The Adaptability of Electrical Driving. B. Longbottom. Extract from a paper read before the Manchester Assn. of Engrs. Shows what efficiencies can be expected with electrical driving, comparing the results with actual tests of mechanical distribution. 3300 w. Mech Engr—April 16, 1904. No. 62333 A.

Modern Methods of Operating Machine Tools Electrically. Abstract of a lecture by Putnam A. Bates, before the Engng. Soc. of Columbia Univ. Discusses the general problems to be considered in selecting a system, and describes a particular system which gives advantages due to its methods of variable-speed control. 2500 w. Sci Am Sup—April 16, 1904. No. 62122.

Motor-Driven Machine Tools. H. M. Phillips. Discusses points of importance in planning an electrical equipment for a shop. 5500 w. Ir Trd Rev—April 7, 1904. No. 61984.

Electrical Works.

The Crocker-Wheeler Plant at Ampere, N. J., and Its Power Distribution. Illustrated detailed description. 4000 w. Ir Trd Rev—April 7, 1904. No. 61983.

Foundry Driving.

The Driving of Machinery and Tools in the Modern Foundry (Einiges über den Antrieb von Maschinen und Werkzeugen in der Modernen Giesserei). J. Groneman. With especial reference to the introduction of electric driving and to the pneumatic operation of moulding machines. 2000 w. Stahl u Eisen—March 15, 1904. No. 62-221 D.

Gear Cutter.

A Large Spur Gear Cutter. illustrates and describes a machine for placing the teeth in spur gears up to 20 feet in diameter and 54-inch width of face. 900 w. Ir Age—March 31, 1904. No. 61824.

Globe Valves.

Some Tools Used in the Manufacture of Globe Valves. J. R. Gordon. Illustrates and describes tools designed to lower the cost of manufacture. 1000 w. Mach, N. Y.—April, 1904. No. 61814 C.

Grinding.

Tool-Grinding Machines. Joseph Horner. The first of a series of articles dealing with the processes and machines employed in the work of grinding tools. Ills. 3500 w. Engng—March 25, 1904. Serial. 1st part. No. 61934 A.

Jigs.

Accurate Drill Jigs. C. L. Goodrich. An illustrated account of extremely careful work to produce jigs in which the limit of variation from specifications allowed between the centers of any two holes was 0.0001 inch. 1500 w. Ir Age—March 31, 1904. No. 61822.

Lathes.

A Backwoods Lathe. John Randol. Illustrated description, with remarks. 1000 w. Am Mach—March 31, 1904. No. 61821.

Lathe Spindle.

Lathe Spindle Design. John Randol. Illustrated description of the Sloan & Chace No. 5 lathe spindle. 1500 w. Am Mach—April 14, 1904. No. 62041.

Lifting Table.

A Lifting Table—Finishing Mower Wheels. S. A. Worcester. Illustrates and describes an application of the spring counter balance, and the operations for finishing mower wheels. 1200 w. Am Mach—April 7, 1904. No. 61965.

Machine Design.

Some Practical Points in Machine Designs. W. S. Leonard. Discusses some of the practical considerations to be kept in mind. 2800 w. Mach, N. Y.—April, 1904. No. 61813 C.

We supply copies of these articles. See page 476.

Milling.

An Indexing Milling Fixture. Jos. M. Stabel. Illustrated description of a fixture used on a sensitive drill press, its indexing mechanism being semi-automatic. 800 w. Am Mach—April 7, 1904. No. 61966.

Milling Machines.

A Slot Milling Machine. Illustrated description of an automatic machine for the slotting of nuts and other small pieces. 700 w. Ir Age—April 14, 1904. No. 62037.

A Special Cam Milling Machine. John Tangye. Illustrated description of a machine which succeeded in greatly reducing the cost of certain details of engines, and in saving much time and labor. 1200 w. Prac Engr—March 25, 1904. No. 61925 A.

Milling Machine Feeds and Speeds. Aims to demonstrate that a guide for determining the proper feed of milling cutters is found in ascertaining the thickness of the chip per tooth of the cutter. Ills. 1200 w. Am Mach—March 31, 1904. No. 61820.

Molding.

Molding a Crane Base. Joseph Horner. Illustrates and describes methods of making a casting without a complete pattern. 1300 w. Am Mach—April 7, 1904. No. 61963.

Molding a Printing Machine Frame. George Buchanan. Illustrates and describes the method of molding in one piece. 800 w. Foundry—April, 1904. No. 62086.

Pickling.

The Pickling of Castings with Acid (Das Putzen der Gussstücke mit Säurewasser). J. L. C. Eckelt. Describing a method in which the dilute acid is sprayed upon the castings by jets instead of immersion in vats. 1500 w. Stahl u Eisen—March 15, 1904. No. 62222 D.

Pipe.

The Manufacture of Welded Pipe. Victor Beutner. An illustrated article reviewing the development and fully describing the process of manufacture. General discussion. 6500 w. Pro Engrs' Soc of W. Penn—Jan., 1904. No. 62305 D.

Planing.

The Planing of Curved Surfaces. Howard A. Coombs. Illustrates and describes some of the attachments to and modifications of planing machines, to adopt them to the finishing of curved instead of plane surfaces. 1000 w. Am Mach—April 21, 1904. Serial. 1st part. No. 62169.

Punch.

A Large Sectional Punch and Die. A. F. Horton. Illustration with details of the method used in manufacturing these large dies. 2200 w. Ir Trd Rev—April 7, 1904. No. 61982.

Punching Machine.

Combined Punching Machine and Slitting Rolls. W. H. Eisenbeis. Illustrated description of a machine for the production of sheet-iron stampings for transformers. 700 w. Am Mach—March 31, 1904. No. 61819.

Screws.

British Association Small Screw Gauge Committee. A Brief review of the origin of this committee and of their final report. 2000 w. Mech Engr—April 2, 1904. No. 62062 A.

Shaper.

A New Design of Back-Geared Shaper. Illustrated description of this tool. 600 w. 2000 w. Mech Engr—April 2, 1904. No. 61834 C.

Slotting Machines.

The Use of Turret Heads on Slotting Machines. R. W. Gulick. Illustrated description of the method used in the works of the Westinghouse Co., resulting in accurate, rapid work of good finish. 700 w. Am Mach—April 7, 1904. No. 61961.

Stock Tracing.

See Industrial Economy.

Tool Works.

The R. K. Le Blond Machine Tool Company's shop. Illustrated detailed description of an interesting shop in Cincinnati, and its equipment. 2500 w. Mach, N. Y. —April, 1904. No. 61812 C.

Tuyeres.

The Area of Cupola Tuyeres (Düsenquerschnitte der Kupolöfen). H. Wedemeyer. Giving applications of working formulas, and discussing the influence of tuyere area on performance. 1800 w. Stahl u Eisen—April 1, 1904. No. 62227 D.

Wage Methods.

See Industrial Economy.

Welding.

Notes on Welding Sheet Iron (Mitteilungen aus der Praxis des Blechschweissens). A. Finke. Describing methods of constructing tubular structures of welded sheet iron, with tests showing their high resistance. 1800 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62207 D.

Works.

The New Engineering Works of Messrs. Graham, Morton & Company at Hunslet, Leeds. An illustrated description of a new British plant. 2700 w. Ir & Coal Trds Rev—March 18, 1904. No. 61792 A.

We supply copies of these articles. See page 476.

MATERIALS OF CONSTRUCTION.

Aluminium.

A New English Aluminium Welding Machine. Illustrated description of the machine and process designed by Sherard Cowper-Coles. 1500 w. Sci Am—April 23, 1904. No. 62198.

The Corrosion of Aluminium and Its Prevention. William Roy Mott. A report of experimental investigations. 700 w. Elec Chem Ind—April, 1904. No. 61978 C.

Alloys.

Antifriction Alloys. John F. Buchanan. A general discussion of these alloys, and points to be observed in compounding. 3300 w. Foundry—April, 1904. No. 62085.

Alumino-Thermics.

Alumino-Thermies, or the Production of High Temperatures by Burning Aluminum. E. Stütz. An explanation of some of Dr. Hans Goldschmidt's remarkable discoveries in the creation of high temperatures by means of aluminum, and the applications made. 4800 w. Jour Fr Inst—April, 1904. No. 62099 D.

The Production of Pure Metals Free from Carbon by the Alumino-thermic method. Hans Goldschmidt. Information on the production of pure metals by this method, and on the uses of such metals in metallurgy. 2000 w. Elec-Chem Ind—April, 1904. No. 61981 C.

"Elastic Limit."

The Use of the Term "Elastic Limit" in Metals Under Stress. W. C. Popplewell. Discusses the true meaning of the term and its limitations. The material referred to is the metals. 4500 w. Engng Rev—April, 1904. No. 62388 B.

Lubricants.

Lubricating Oils and Their Properties—How to Test Them and to Detect Adulterations. William Davis. 900 w. Power—April, 1904. No. 61832 C.

The Selection and Testing of Lubricants. A. O. Doane. Information concerning various oils, with suggestions helpful in selecting and testing. 2000 w. Power—April, 1904. No. 61831 C.

Microstructure.

The Relation of Microstructure to the Rate of Cooling. W. Campbell. A lecture to the Philadelphia Found. Assn. An illustrated study of alloys, showing that changes occur far below the freezing point which are of great importance. 2500 w. Ir Age—April 21, 1904. No. 62174.

Tool Steels.

Experiments with Rapid Cutting Steel Tools. Charles Day. Abstract report of a series of tests carried out in Manchester, Eng., giving results and calling attention to important points. Plate. 3000 w. Trans Inst of Engrs & Shipbuilders of Scotland—Feb. 23, 1904. No. 62317 D.

High Speed Steels. William Lodge. Prepared for the convention of the Nat. Metal Trds. Assn. Deals with the methods and materials necessary to produce desired results. 2800 w. Ir Age—April 7, 1904. No. 61887.

Notes on Tests of Rapid-Cuting Steel Tools. C. Pendlebury. On the tests made by a joint committee consisting of members of the sub-committee of the Manchester School of Technology. The trials were confined to lathe tools. 5000 w. Engr, Lond—April 1, 1904. No. 62076 A.

The Use of High-Speed Steels. E. R. Markham. Suggestions in regard to the use of this material. 1500 w. Am Mach—April 7, 1904. No. 61964.

MEASUREMENT.

Anemometers.

The Determination of Air Currents in Testing Anemometers (Ueber Mitwindbestimmung bei Anemometer-Prüfungen). H. Stach. An examination of the method of testing anemometers by subjecting them to known air currents; showing the importance of correcting for the motion of the air in the room. 1000 w. Glückauf—March 19, 1904. No. 62240 D.

Hardness.

The Steel Ball Test (Die Kugel-druck Prüfung). Albert Ohnstein. Describing an improved apparatus for applying the Huber modification of Brinell's test for hardness; using the depression made by a steel ball as a measure. 1000 w. Stahl u Eisen—April 1, 1904. No. 62226 D.

Humidostat.

The Control of Humidity by Means of the Humidostat. W. S. Johnson. A brief illustrated explanation of a method of controlling humidity. 1400 w. Eng News—April 21, 1904. No. 62181.

Micrometers.

Determining the Errors in Screws. Robert A. Bruce. A screw-measuring apparatus is illustrated and described, with the method of using. 1200 w. Am Mach—April 7, 1904. No. 61969.

Temperature.

The Measurement of Temperature. Robert S. Whipple. Gives a summary of the various means of measuring temperature in general use, and tests of their applications. Ills. 3000 w. Engng Times—March, 1904. No. 62385 B.

Testing.

The Equipment of an Engine Test House. R. K. Morcom. A brief account of the evolution of a plant for testing

We supply copies of these articles. See page 476.

combined sets for electricity stations, and of some of the more interesting results obtained. Also discussion. 4200 w. Elec Rev, Lond—March 25, 1904. No. 61-930 A.

POWER AND TRANSMISSION.

Belts.

Graphical Diagrams for Determining Belt Widths (Graphische Tabelle zur Bestimmung der Riemenbreite). Prof. Rudolf Escher. Deriving curves which enable the power transmitted by belts to be determined by inspection, for various speeds and pulley diameters. 1200 w. Schweizerische Bauzeitung—March 19, 1904. No. 62229 D.

Cableways.

Aerial Ropeway for Contractors' Work. Daniel Bellet. Gives an illustrated description of the construction of a railway in the French Pyrenees, in which an aerial ropeway was first built for transporting the necessary material. 1000 w. Trac & Trans—April, 1904. No. 62081 E.

Cableways for Open-Pit Mining. Spencer Miller. An illustrated article discussing the advantages of horizontal cableways and those of the radial type. 1800 w. Mines & Min—April, 1904. No. 61-949 C.

Suspension Cableways. Andrew A. Bruch. An illustrated article explaining the use and construction of inclined and horizontal cableways. 3300 w. Mines & Min—April, 1904. No. 61946 C.

Wire-Rope Tramway at Grand Encampment, Wyoming. Illustrated description of a line sixteen miles long. 2800 w. Mines & Min—April, 1904. No. 61959 C.

Chains.

Construction of the West Point Chain. E. P. Buffet. An account of the chain stretched across the Hudson River by the American Army during the Revolutionary War, giving authentic records in regard to its manufacture. 2500 w. Am Mach—April 21, 1904. No. 62172.

Compressed Air.

Air Compressor Plant at Marshall Field Store, Chicago, Ill. Illustrated detailed description of this plant. 1700 w. Compressed Air—April, 1904. No. 62340.

Explosions in Air Compressors. E. Goffe. Read before the Mech. Engrs'. Assn. of the Witwatersrand. Describes conditions under which explosions occurred in South Africa, discussing the causes. 2400 w. Mech Engr—April 16, 1904. No. 62334 A.

Conveyors.

Mechanical Conveyors. Walter Renton Ingalls. Deals with the use of conveyors for the transportation of ore and other mineral substances. 2500 w. Eng & Min Jour—April 21, 1904. Serial. 1st part. No. 62193.

Travelling Blocks and Hoists. Illustrates and describes apparatus used with the overhead trolley conveying, stating the uses to which this form of transport may be applied and its advantages. 3500 w. Ir & Coal Trds Rev—March 11, 1904. No. 61791 A.

Elevators.

Elevators: Their Construction and Operation—Horizontal Cylinder, Hydraulic Elevators, Pushing Type. William Baxter, Jr. Explains the difference between the pulling and the pushing types of horizontal hydraulic elevators, illustrating details. 1200 w. Engr, U S A—April 15, 1904. Serial. 1st part. 62136 C.

Mechanical Plant.

The Mechanical Plant of the Minnesota State Capitol. Illustrates and describes the plant for this building in St. Paul, which is heated by the plenum system, lighted by electricity, provided with hydraulic elevators and furnished with water distribution, and extensive call-bell and telephone systems. 4500 w. Eng Rec—April 16, 1904. No. 62127.

Repairs.

Repairs in a Power Plant. William J. Kaup. The present article deals with conditions essential to be understood by the workman. Ills. 900 w. Engr, U S A—April 1, 1904. Serial. 1st part. No. 61857 C.

Ropes.

Effects of Bending Stresses on Wire Rope. J. B. Richards. How excessive bending may entirely destroy the safe working strength of a rope. 1200 w. Mines & Min—April, 1904. No. 61956 C.

Formulæ for Calculating the Size of Wire Ropes. Sheldon Smillie. Gives empirical formulæ deduced from tables published by J. A. Roebling's Sons Co., and found to give the same results as the table. 700 w. Sch of Mines Qr—Jan., 1904. No. 62309 D.

Glossary of Rope Terms. With special reference to the meanings of words used in connection with the manufacture and use of wire rope. Ills. 1500 w. Mines & Min—April, 1904. No. 61951 C.

History of Wire Rope. Brief account of the early use of rope and illustrated description of some of the modern varieties. 2300 w. Mines & Min—April, 1904. No. 61957 C.

Hoisting Ropes. George S. Whyte. Considers quality of materials, methods of manufacture, style of lay, and their influence on wearing qualities. 2400 w. Mines & Min—April, 1904. No. 61954 C.

We supply copies of these articles. See page 476.

Practical Points in the Construction and Use of Wire Rope. L. C. Moore. Considers material, tensile strength, load, sheaves, causes of wear, etc. 4300 w. Mines & Min—April, 1904. No. 61947 C.

Splicing Wire Ropes. Illustrates and describes the method recommended by the John A. Roebling's Son's Company, of Trenton, N. J. 1000 w. Mines & Min—April, 1904. No. 61952 C.

The Transmission of Power by Ropes. Edwin Kenyon. Abstract of a lecture delivered at the Blackburn Technical School. Considers cost, applications, the various systems, the construction of ropes, splicing, etc. Ills. 5300 w. Mech Engr—March 26, 1904. No. 61926 A.

The Transmission of Power by Wire Rope. W. H. Graves. Illustrated description of a system known as the single loop, a modification of belt driving, grooved wheels being used in place of pulleys, and an endless wire rope in place of a belt. 3800 w. Mines & Min—April, 1904. No. 61955 C.

Wire-Rope Calculations. A comparison of the methods of determining the proper working load for wire rope. 2500 w. Mines & Min—April, 1904. No. 61960 C.

See also Mining and Metallurgy, Mining.

Spring Motor.

The Pfeiffer Spring Motor. An explanation of the sense in which the term "spring motor" is used is given, with an illustrated description of the mechanism. 1600 w. Ir Age—April 7, 1904. No. 61886.

Worm Gears.

Worm Gear Experiences—Warnings and Examples. J. E. Johnson, Jr. Illustrates a short tooth worm gear, and gives information gained from the materials used, and the construction. 2200 w. Am Mach—April 21, 1904. No. 62170.

STEAM ENGINEERING.

Boiler Explosions.

Boiler Design and the Causes of Boiler Explosions. R. S. Hale. A study of government and insurance records, showing the controlling influence of sound design upon safety. 5000 w. Engineering Magazine—May, 1904. No. 62275 B.

Boilers.

Cleaning Steam Boiler Surfaces. R. T. Strohm. Describes methods used for cleaning shell and tubular boilers. Ills. 2500 w. Am Elect'n—April, 1904. No. 61892.

The Practical Management of Stationary Steam Boilers. R. T. Cooke. An account of the everyday management of steam boilers, with a view to maximum efficiency and a minimum production of smoke. 4000 w. Engr, Lond—April 15, 1904. No. 62346 A.

Boiler Tests.

Report of Competitive Tests Between Babcock & Wilcox and Stirling Boilers, made at Los Angeles, Cal., 1903. Full report covering every detail of the tests made of these water-tube boilers when burning oil, and giving a great amount of information. Ills. 10000 w. Jour of Elec—April, 1904. No. 62148 C.

Boiler Tubes.

Setting Boiler Tubes. Illustrates and describes various tools used and methods devised. 1000 w. Am Mach—April 21, 1904. No. 62171.

Engines.

Modern High-Speed Steam Engines. Considers the development of the high-speed engine, describing the "Willans" as representing the single-acting type, and the "Belliss" engine for the double-acting type. 2000 w. Engr, Lond—April 15, 1904. Serial. 1st part. No. 62342 A.

The Economy of Reciprocating Engines at Light Loads as Compared with that of Steam Turbines. J. A. Seymour. Gives results of tests made, with explanatory notes. 1800 w. Power—April, 1904. No. 61833 C.

The Internal Surfaces of Steam Engines. W. H. Booth. Discusses points in designing with a view to diminishing the internal surfaces to a minimum, and the question of superheated steam. 2500 w. Engr, U S A—April 15, 1904. No. 62135 C.

150-Horse-Power Compound Electric Light Engines for the Royal Navy. Illustrated description of the engines of two electric generating sets to be installed on the Téméraire, a training vessel for lads to become engine-room artificers. This vessel will be the central generating station, supplying power to two floating factories and for lighting. 1300 w. Engng—April 15, 1904. No. 62352 A.

"Entropy."

A Criticism of Mr. James Swinburne's "Entropy." Robert H. Smith. Criticizes recent work published in two particulars—the clearness of the theories, and the accuracy of mathematical developments. 2700 w. Elec Rev, Lond—April 15, 1904. No. 62336 A.

Entropy. John Perry. A criticism of the work by James Swinburne, recently published. 3500 w. Nature—April 14, 1904. No. 62355 A.

Exhaust Steam.

Utilizing the Exhaust of Intermittently-Working Engines. J. Walter Pearse. Il-

lustrates and describes Prof. Rateau's system of steam accumulator regenerator and low-pressure steam turbine for utilizing waste steam. 4000 w. Engng Rev—March, 1904. No. 62390 B.

Indicators.

The Direct Production of Time Diagrams from Ordinary Indicators (Verfahren zur unmittelbaren Entnahme von Zeitdiagrammen mit Gewohnlichen Indikatoren). W. Schüle. Describing the making of indicator diagrams by giving the drum a uniform rotary motion independently of the motion of the engine. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—March 26, April 2, 1904. No. 62202 each D.

Liquid Fuel.

Liquid Fuel Burners. J. S. V. Bickford. The present article considers the class of vapor burners designed for the use of petroleum lamp oil, discussing the production of the vapor. Ills. 4400 w. Engng—April 15, 1904. Serial. 1st part. No. 62351 A.

Locomotive Boilers.

Designing of Locomotive Boilers. Roger Atkinson. Considers the general principles and discusses details. 1500 w. Loc Engng—April, 1904. Serial. 1st part. No. 61879 C.

Lubrication.

The Crandall Mechanical Lubricating System. Illustrated description. 1000 w. Ir Age—April 14, 1904. No. 62040.

Piping.

Something About Piping. W. H. Wakeman. Suggestions concerning the location and operation of pipes in steam plants. 1400 w. Power—April, 1904. No. 61829 C.

Regulation.

Automatic Governing of Marine Engines. H. M. Wilson. Read before the N. E. Coast Inst. of Engrs. & Shipb'ldrs. States facts showing the need of marine reciprocating engines having a good automatic governor, illustrating and describing the principal governors. 4800 w. Mech Engr—April 16, 1904. No. 62332 A.

Rotary Engines.

Antiquity of the Rotary Engine. E. P. Buffet. Illustrates two models of early dates, embodying this principle. One about 1796, the other much earlier. 1500 w. Power—April. 1904. No. 61828 C.

Steam Pumps.

See Mechanical Engineering, Hydraulics.

Superheating.

Superheated Steam. F. J. Rowan. Continued discussion and correspondence in connection with this paper. 4500 w. Trans Inst of Engrs & Shipbuilders in Scotland—Feb. 23, 1904. No. 62314 D.

The Conveying of Superheated Steam (Die Fortleitung des Ueberhitzten Wasserdampfes). Dr. Otto Berner. A discussion of the losses in carrying superheated steam through pipes. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—April 2, 1904. No. 62204 D.

Turbines.

Reciprocating Sets vs. Turbo-Generators. I. William Chubb. Reports trials made, as a contribution to the discussion on the relative advantages in connection with power house-plants. 1800 w. Power—April, 1904. No. 61830 C.

Steam Turbines (Ueber Dampfturbinen). Dr. A. Riedler. A general review of the development of the steam turbine, with especial reference to the Riedler-Stumpf turbine. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—March 25, April 1, 1904. No. 62209 each D.

Steam Turbines v. Reciprocating Engines. J. H. Barker. Considers the advantages of turbines as compared with reciprocating engines, and concludes that reciprocating engines will be in demand for powers to 1,000 h. p., and above such a power the trend of opinion is toward turbines. 4500 w. Engng Rev—March, 1904. No. 62389 B.

The De Laval Steam Turbine. Charles Garrison. An illustrated detailed description of the principal parts of the De Laval steam turbine, stating its advantages over the reciprocating engine, its economical operation, types, uses, &c. 5800 w. Tech Qr—March, 1904. No. 62356 E.

The Steam Turbine and Its Field in Marine Work. Lieut. H. C. Dinger. Gives a brief résumé of the advantages of the turbine, in distinction from the reciprocating engine, and the types of craft that the turbine would be suitable for; also the types of turbines proposed for marine work. 2000 w. Sci Am—April 9, 1904. No. 62006.

The Steam Turbine as an Exhaust-Steam Utilizer. From *Le Génie Civil.* Describes an installation in the mines at Bruay where a combination of accumulator and turbine is used as brought out by Prof. Rateau. 2000 w. Eng Rec—April 23, 1904. No. 62373.

The Steam Turbine in Power House Extensions. Illustrated description of an interesting application of the steam turbine at the station of the Rockland Light and Power Company, at Orangeburg, N. Y. 1800 w. Am Elect'n—April, 1904. No. 61890.

The Yale & Towne Mfg. Company's

We supply copies of these articles. See page 476.

Power Plant. An illustrated description of the first plant in which the use of the steam turbine was commercially attempted outside of the works of the builders of the turbine. 1800 w. Ir Age—April 21, 1904. No. 62173.

See also Marine and Naval Engineering.

Valves.

Reversing Valves for Regenerative Furnaces. A. D. Williams, Jr. Shows the losses due to a poor valve, and comments on some good valves. 2000 w. Ir Age—April 7, 1904. No. 61889.

Setting the Valves of the Brown Engine. Illustrated directions. 2000 w. Power—April, 1904. No. 61826 C.

MISCELLANY.

Aeronautics.

The Beedle Airship. Illustrated description of the novel features. The frame is arranged in the form of a triangle, within which is placed the motor, and the aeronaut's basket. 700 w. Sci Am—April 16, 1904. No. 62120.

Gunsight.

The "Grubb" Sight. Description, illustrations, and explanation of its application. 2800 w. Jour U S Art—March, 1904. No. 62304 D.

Laboratories.

The National Physical Laboratory. A summary of the work done and of the instruments and machines thus far added to the equipment, with information concerning the needs, etc. 4800 w. Engng—March 25, 1904. No. 61933 A.

Pulverizers.

The Action of Ball Mills (Der Arbeitsvorgang in Kugelmühten). Hermann Fischer. An examination of the action of pulverizers in which steel balls are used in a revolving cylinder. Photographs at various speeds are given. 2500 w. Zeitschr d Ver Deutscher Ing—March 26, 1904. No. 62201 D.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

Briquetting Fuel Material. George E. Walsh. Considers the waste material which contains sufficient burning properties to utilize as fuel, the efficiency and cost of briquetting, and related subjects. 3500 w. Power—April, 1904. No. 61827 C.

Recent Advances in the Utilization of Peat and Lignite. H. H. Wotherspoon, Jr. Abstract of a paper read before the N. Y. Acad. of Sci. concerning the manufacture and cost of briquettes in Europe. Ills. 600 w. Eng & Min Jour—April 7, 1904. No. 61988.

Central Asia.

Coal and Petroleum in Central Asia. E. D. Levat. Translated from paper entitled "Richesses Minérales des Possessions Russes en Asia Centrale." Concerning the deposits, their location, geology, etc. 2300 w. Eng & Min Jour—April 7, 1904. No. 61990.

Coal-Field.

A Missouri Coal-Field. William Griffith. Describes a bituminous field near the St. Louis, Kansas & Colorado railroad. Ills. 600 w. Eng & Min Jour—April 7, 1904. No. 61989.

Coking.

The Coking of Lignite at Zsiltale in Hungary (Die Verkokung der Braunkohle im Zsiltale in Ungarn). A. Semlitsch. Describing the successful production of blast-furnace coke by coking compressed briquettes of lignite. Analyses of the lignites given and details of the oven and furnaces. Two articles, 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 12, 19, 1904. No. 62231 each D.

The Méguin Coke Oven Charger. O. Simmersbach, in *Stahl und Eisen*. Illustrates and describes the destinctive features; the chief is the stamping mechanism, by means of which the charge is compressed before introducing into the ovens. 900 w. Col Guard—April 8, 1904. No. 62158 A.

Crow's Nest.

Notes on Some Special Features of Coal Mining in the Crow's Nest. James McEvoy. Read at meeting of the Canadian Min. Inst. Describes the geology of this region and the physical and chemical properties of the coal. 1800 w. Can Min Rev—March 31, 1904. No. 61810 B.

Fifeshire.

The Fifeshire Coalfields. Extract from the *Dunfermline Express*. Description of the collieries working the Dunfermline Burgh mineral royalties. 2000 w. Col Guard—April 8, 1904. No. 62159 A.

Pocahontas.

The Coals and Coal Mining Methods of the Pocahontas Field. George L. Fowler.

We supply copies of these articles. See page 476.

The first article is devoted to the geological and operative features of the district, with numerous illustrations. Serial, Part I. 4000 w. Engineering Magazine—May, 1904. No. 62274 B.

COPPER.

Concentration.

Concentrating Methods at La Cananea, Sonora, Mexico. D. Cole. Describes the plant and the flow of material in a single section of concentrator. Copper. Ills. 1200 w. Min Rept—April 14, 1904. No. 62139.

GOLD AND SILVER.

Boundary District.

Gold and Silver Mines near Greenwood. E. Jacobs. Information concerning the mineral claims of this district, especially the Providence, Elkhorn and E. P. U. mines. Ills. 2800 B C. Min Rec—April, 1904. No. 62014 B.

Canvas Tables.

Canvas Tables. H. P. Stow. From the Trans. Cal. Min. Assn. Describes a canvas table of unusual design and explains its advantages. 1800 w. Min & Sci Pr—March 26, 1904. Serial. 1st part. No. 61884.

Chlorination.

Fuel Oil in Roasting for Chlorination. E. C. Voorhies. From Trans. Cal. Min. Assn. Briefly describes the furnace used, and its operation, detailed statement of the amount of oil and coal used. 1000 w. Min & Sci Pr—March 26, 1904. No. 61885.

Concentration.

Wet Concentration of Ores by the Sherman System. Frederick Wooster Sherman. An illustrated description of this system, with the results obtained. 3000 w. Min & Sci Pr—March 26, 1904. No. 61883.

Cyanide.

Estimation of Available Cyanide. J. E. Clennell. Considers some of the factors upon which the efficiency of a cyanide solution depends, and gives a method of comparing the solvent activity of solutions. 1200 w. Eng & Min Jour—March 31, 1904. No. 61838.

The Determination of Constants in Working Cyanide Solutions. Gerard W. Williams. Gives the results the author obtained from a series of experiments instituted with a view to determining the dissociation and hence the gold-solvent power of the double cyanide of zinc and potassium in the presence of the factors usually found in a working cyanide solution. 8500 w. Jour of Chem, Met & Min Soc of S Africa—Feb., 1904. No. 62152 E.

Dredging.

The Gold Dredging Industry. F. W. Griffin. Trans. Col. Min. Inst. Information concerning dredges and dredging, and the rapid development of this business. 3000 w. Min & Sci Pr—April 16, 1904. No. 62382.

Filter Pressing.

Filter-Pressing in Western Australia. W. A. Prichard. Illustrates and describes the filter-press treatment of slimes at Kalgoorlie. 2000 w. Eng & Min Jour—April 14, 1904. No. 62113.

Korea.

Gold Mining in Korea. H. C. Perkins. Information concerning the deposits and methods of mining. 1000 w. Eng & Min Jour—April 7, 1904. No. 61986.

Machinery.

Choice of Gold Mining Machinery. Donald Clark. Suggestions for the selection of suitable machinery, and related subjects. 2500 w. Aust Min Stand—Feb. 18, 1904. Serial. 1st part. No. 61924 B.

Mexico.

The Guanajuato Mining District. Robert T. Hill. Map, illustrations, history and description of recent progress. 2500 w. Eng & Min Jour—April 14, 1904. Serial. 1st part. No. 62112.

The Ocampo District, Mexico. Arthur K. Townsend. An account of this silver-bearing region, the methods of mining, etc. 2500 w. Eng & Min Jour—March 31, 1904. No. 61839.

Milling Practice.

Notes on Mill Construction, Milling and Amalgamation. I. Roskellev. Calls attention to some alterations that would improve the mills of the Witwatersrand, and points in mill construction, describing milling practice. 7400 w. Jour of Chem, Met, & Min Soc of S Africa—Feb., 1904. No. 62151 E.

Placer Mining.

The Pump in Placer Mining. J. A. Yeatman. An illustrated description of a placer mine using artificial pressure head produced by step pressure pumps. 1200 w. Min & Sci Pr—April 2, 1904. No. 62033.

Roasting.

The Merton Furnace (Der Mertonofen). Gustav Kroupa. Describing the Merton roasting furnace as used by the Great Boulder Co. at Kalgoorlie. The ore is kept moving continually through the furnace by the action of revolving arms. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 9, 1904. No. 62238 D.

Russia.

Free Gold in Basic Igneous Rocks in Southeastern Russia. W. H. Weed. Describes the occurrence and discusses the

We supply copies of these articles. See page 476.

origin of the gold and silver. 1300 w. Eng & Min Jour—March 31, 1904. No. 61842.

Screens.

Capacity of Revolving Screens. J. M. Callow. Gives results of experiments showing the comparative capacities of different size screen cloth, and the different rates of travel of ore for different slopes. 600 w. Min Rept—April 7, 1904. No. 62015.

Stamp Mills.

A High-Speed Gravitation Stamp Mill. Edgar Smart. Illustrates and describes new type recently tried in Johannesburg. The results are a marked advance in existing practice. 3800 w. Page's Mag—March, 1904. No. 62386 B.

Transylvania.

The Gold Mines of Nagyag (Der Goldbergbau Nagyág). Julius Steinhausz. A general account of the important mines at Nagyag, in Transylvania, with topographical map and profile. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 2, 1904. No. 62235 D.

IRON AND STEEL.

Blast Furnaces.

Modern Blast-Furnace Construction (Gesichtspunkte beim Bau Modernen Hochöfen). E. Lamoureux. A review of modern furnace construction, comparing European and American practice. 3000 w. Stahl u Eisen—April 1, 1904. No. 62224 D.

Stock Distribution and Its Relation to the Life of a Blast-Furnace Lining. David Baker. A discussion of difficulties due to mechanical handling and the efforts made to remedy the troubles, with partial success. Ills. 2000 w. Ir & Coal Trds Rev—April 8, 1904. No. 62166 A.

Cranes.

Furnace Charging Cranes. Illustrates and describes modern types of cranes for this purpose. 2500 w. Ir & Coal Trds Rev—April 1, 1904. No. 62083 A.

Electric Driving.

The Cascade Connection of Motors in Rolling Mills. E. Danielson, in the *Elektrotechnische Zeitschrift.* Gives a description of one of the three-speed motors. Ills. 1200 w. Elec Engr, Lond—April 1, 1904. No. 62063 A.

Mesabi District.

Mining Methods in the Mesabi Iron District, Minnesota. Kirby Thomas. An illustrated description of mining principally by the open-cut method with steam shovels. 2500 w. Min & Sci Pr—April 16, 1904. No. 62381.

Open Hearth.

Gas Losses in Open-Hearth Furnaces (Die Gasverlustee der Siemensöfen). Fr. Schraml. An examination of the various sources of leakage and losses of fuel gas in supplying open-hearth furnaces, with suggestions for improvements in the valves. 1800 w. Stahl u Eisen—March 15, 1904. No. 62218 D.

The New Open Hearth Steel Works of the French Navy at Guérigny (Das Neue Martinstahlwerk der Französischen Marine in Guerigny). Illustrating and describing the new works for the manufacture of armor-plate steel, with especial reference to the furnaces. 1500 w. Stahl u Eisen—March 15, 1904. No. 62217 D.

Ore.

The Iron Ore Deposits of Galicia (Eisenerzvorkommen in Galicien). H. Teichgrüber. A brief description of the deposits in the vicinity of Vigo and Corunna, Spain. 1800 w. Stahl u Eisen—March 15, 1904. No. 62216 D.

Piping.

The Development of the Riemer Process for Preventing Piping of Steel Ingots (Weitere Entwickelung des Reimerschen Verfahren zur Herstellung Dichter Stahlblöcke). Giving photographs of sections of ingots showing the great reduction in piping and porosity by use of the new process. 1000 w. Stahl u Eisen—April 1, 1904. No. 62225 D.

Rod Mills.

The Construction and Operation of Wire Rod Rolling Mills (Ueber Bau und Betrieb von Drahtwalzwerken). J. Hübers. Describing various arrangements of rolls for continuous mills, including one in which they are placed side by side, the rod passing around in a spiral. 2000 w. Stahl u Eisen—March 15, 1904. No. 62220 D.

The New Wire-Rod Rolling Mill at Differdingen (Die Neue Drahtwalzwerksanlage in Differdingen). K. Gruber. Describing a plant in which the rolls are driven by a double gas engine, operating with blast-furnace gas. 2000 w. 1 plate. Stahl u Eisen—April 1, 1904. No. 62223 D.

Separators.

Swedish Ore Separators (Schwedische Erzscheideapparate). Dr. Leo. Giving a series of brief notices of all the magnetic iron-ore separators which have been used in Sweden. Two articles, 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 25, April 2, 1904. No. 62234 each D.

The Forsgren Magnetic Separator (Neues Separatorsystem zur Aureicherung Von Magneteisenerzen des Ingénieurs Emil Forsgren). Dr. Leo. Describing the work of magnetic concentration of magnetite ores at Falun, Sweden. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 12, 1904. No. 62232 D.

We supply copies of these articles. See page 476.

Steel Process.

The Production of Steel Without the Use of Scrap or Ore (Stahlerzeugung ohne Verwendung von Alteisen und Erz). Oskar Goldstein. Describing a combined converter and open-hearth process used in Mexico. 1000 w. Stahl u Eisen—March 15, 1904. No. 62219 D.

Valuation.

The Valuation of Iron Ores (Zur Frage des Eisenerzbewertung). Oskar Simmersbach. An examination of the method of valuing iron ores according to chemical composition, taking into account the degree of fusibility and ease of reduction, together with the process for which they are intended. 3000 w. Glückauf—March 19, 1904. No. 62239 D.

The Calculation of the Value of the Raw Material in Pig Iron Making. A. P. Gaines. Describes the method adopted by the writer for determining the relative value. 2500 w. Ir Age—April 14, 1904. No. 62039.

MINING.

British Columbia.

The Atlin District. W. Wallace Grime. Information concerning the mining laws, the methods, and the development. 1100 w. Eng & Min Jour—March 31, 1904. No. 61843.

Cableways.

See Mechanical Engineering, Power and Transmission.

Converters.

Converter Accessories. C. H. Glasser. An illustrated article describing the machinery equipment of a converter plant. 2300 w. Eng & Min Jour—March 31, 1904. No. 61841.

Electric Plant.

Electric Installation at the Noel-Sart-Culpart Collieries, Belgium. Illustrates and describes a plant of sufficient capacity to drive a hoisting engine, an underground pump, feed incandescent lamps for lighting the mine, drive an electric fan and the coal briquette factory. 2200 w. Ir & Coal Trds Rev—April 8, 1904. No. 62165 A.

The Electric Power and Transmission Plant at the Courl Mines (Die Elektrischen Kraftübertragungs Anlagen der Zeche Courl). H. Schulte. An account of a complete electric power installation in the Dortmund district; about 700 h. p. being used for hoisting, pumping, ventilation, and other work. 3000 w. 2 plates. Glückauf—April 9, 1904. No. 62243 D.

Fires.

The Handling of Underground Fires with Milk of Lime (Behandlung von Grubenfeuren mit Kalkmilch). Wolfgang Kummer. Describing a method of extinguishing fires behind masonry walls or closed workings by the injection of milk of lime under high pressure. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 9, 1904. No. 62236 D.

Guides.

Some Varieties of Wood Battery Guides. W. J. Sharwood. Brief illustrated descriptions of forms used, and information concerning them. 1200 w. Min & Sci Pr—April 9, 1904. No. 62143.

Great Basin.

Geology and Economics from the Wasatch to the Sierra Nevada. A. Lakes. Illustrated description of this region and the substances of economic value found. In the plain region, salt, borax, soda and nitre are mined. The hills and volcanic rocks contain the precious metals. 2300 w. Min Rept—April 21, 1904. No. 62363.

Haulage.

The Development of the Electric Mining Locomotive. Frank C. Perkins. Illustrated detailed description of patents for mining cars and locomotives and systems of transportation and haulage by electricity in mines. 1200 w. Sci Am Sup—April 23, 1904. Serial. 1st part. No. 62300.

Wire Rope Haulage Problem. George S. Whyte. Explains method of calculating for the application of the Gunckel endless rope system of haulage. Ills. 1200 w. Mines & Min—April, 1904. No. 61948 C.

Wire-Rope Slope Haulage. An illustrated description of an arrangement for hauling on a slope under difficult conditions, with a record of the life of wire ropes. 1200 w. Mines & Min—April, 1904. No. 61950 C.

Wire Rope Tramways. J. H. Janeway, Jr. Illustrates and describes different styles of tramways, the methods of construction and circumstances suited to tramway transportation. 5200 w. Mines & Min—April, 1904. No. 61953 C.

Hoists.

Recent German High Power Electric Mining Hoists. Frank C. Perkins. Illustration and description of a direct-current mining hoist and a motor generator with a 40-ton flywheel for operation and connection with the same installed at Merklinde, I. W., Germany. 1300 w. Min Rept—April 21, 1904. No. 62364.

Some Mine Head Frames and Hoists. Walter W. Bradley. Illustrated descriptions of examples noted by the writer. 1400 w. Min & Sci Pr—April 16, 1904. No. 62383.

Test of Steam Consumption of the Electric Hoisting Machine at the Preussen Mine (Versuche zur Bestimmung des Dampfverbrauches an der Elektrischen

We supply copies of these articles. See page 476.

Fördermaschine der Zeche Preussen II.). H. Schulte. Giving diagrams showing result of tests including efficiency of engine and dynamo. 1800 w. Glückauf—March 26, 1904. No. 62242 D.

Mine Models. E. S. Sheffield, Jr. Discusses methods that have been tried to quickly and clearly illustrate underground conditions, and describes the satisfactory model devised and used at the Treadwell mine, Alaska. 700 w. Cal Jour of Tech —April, 1904. No. 61973 C.

New Zealand.

Mining in New Zealand: Past and Present. Henry A. Gordon. Abstract of presidential address delivered at meeting of the Australasian Inst. of Min. Engrs. 5500 w. N Z Mines Rec—Feb. 16, 1904. No. 62053 B.

Pumping.

Bore-Holes for Pumping Purposes. Edward S. Wight. Read before the N. of England Inst. of Min. Engrs. Describes a method by which a bore-hole can be used for pumping purposes, not as an engineering feat, but to show that mine water may be delivered direct to the surface. 1500 w. Min Rept—April 21, 1904. No. 62365.

Queensland.

Wolfram and Molybdenite Mining. From the report of Walter E. Cameron. Gives history, statistics, geology and report of demands for those minerals, describing the Lappa Lappa lodes and the Tinaroo lodes. 4000 w. Queens Gov Min Jour—Feb. 15, 1904. No. 61896 B.

Ropes.

Notes on Mine Ropes. Charles W. Comstock. Considers the various materials of which ropes are made, their endurance under tests and use, forms of strand and methods of construction. 8000 w. Mines & Min—April, 1904. No. 61958 C.

See Mechanical Engineering, Power and Transmission.

Shafts.

A Concrete Lined Shaft. Describes in detail the work of lining the Grassy Island shaft of the D. & H. Co., near Olyphant, Penn. 1200 w. Eng & Min Jour—April 21, 1904. No. 62194.

Supports.

The Use of Iron Supports for Underground Workings (Ausbau von Abbaubetrieben mit Eeisernen Stempeln). H. Middendorf. An examination of the use of iron pipe for supporting mine workings in place of the usual timbering. 2000 w. Glückauf—March 26, 1904. No. 62241 D.

Timbering.

The Most Rational Method of Timbering Inclined Workings (Welche Abbaumethode ist für Steile Gänge die Rationellste). Franz Mládek. A comparison between the advantages of vertical posts and inclined struts in timbering sloping mine workings. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 9, 1904. No. 62237 D.

MISCELLANY.

Aluminium.

Aluminium: A New Process of M. Gustave Gin. P. McN. Bennie. Concerning an aluminium process recently patented. 1500 w. Elec Chem Ind—April, 1904. No. 61979 C.

Bauxite.

Bauxite in Arkansas. W. F. B. Berger. Illustrates and describes the deposits, with information concerning the uses of this mineral. 1200 w. Eng & Min Jour—April 14, 1904. No. 62114.

Laboratories.

The Equipment of Mining Laboratories. Henry S. Munroe. Discusses the equipment of laboratories at schools of engineering for mining instruction. 2500 w. Eng & Min Jour—April 7, 1904. No. 61987.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Truth is Better Than Comfortable Error. Editorial discussion of railway accidents, and the comparison between America and England as made by Mr. Slason Thompson. 1800 w. Loc Engng—April, 1904. No. 61881 C.

Experiments.

Train Experiments on the London and North-Western Railway. Gives report of trial trips made with a new type of engine, the Precursor, No. 513, for heavy traffic. Diagrams. 500 w. Engr, Lond—April 15, 1904. No. 62347 A.

Stopping.

Stopping with Engine Reversed and Air Brakes Applied vs. Stopping with Air Brakes Alone. Editorial discussion of the best practice, favoring the latter method. 1200 w. Loc Engng—April, 1904. No. 61880 C.

Train Orders.

Is the "19" Form of Train-Order Un-

We supply copies of these articles. See page 476.

safe? H. W. Forman. A discussion of train orders, and collisions and accidents due to their misinterpretation. 2500 w. R R Eng—April 8, 1904. No. 62000.

Trans-Siberian.

Military Aspects of the Trans-Siberian Railway. Illustrations and discussion of the value of this road in the present war with Japan. 1800 w. Sci Am—April 16, 1904. No. 62118.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Some Hints on Care of the Automatic Slack Adjuster. An illustrated explanation of important points in the proper management of the adjuster. 600 w. Loc Engng—April, 1904. No. 61882 C.

The Corrington Air Brake. Illustrated description of a system combining automatic and straight air apparatus in such a way as to maintain each at all times independent of the other. 1800 w. Am Engr & R R Jour—April, 1904. No. 61837 C.

The Siemens System of Electrically Controlled Compressed Air Brakes. Abstract from *Glasers Annalen für Gewerbs und Bauwesen.* A discussion of general considerations, with an illustrated description of the Siemens system and information concerning it. 5800 w. Bul Int Ry Cong—March, 1904. No. 61796 E.

Cars.

New "High-Capacity" Wagons on the Great Central Railway. Illustrated description of 30-ton all steel bogie and cars. 2000 w. Ir & Coal Trds Rev—April 1, 1904. No. 62082 A.

New Rolling Stock for the Rhodesia Railways. Illustrates and describes special cars designed for the use of several of the officers of the line, providing comfortable accommodation for day and night. 1000 w. Engr, Lond—April 1, 1904. No. 62077 A.

Self-Emptying Coal Wagons. Illustrates and describes cars provided with doors of special design in the floors. 600 w. Engr, Lond—April 1, 1904. No. 62078 A.

Steel in Car Construction. C. A. Seley. Suggestions for the use of steel in the box cars and coal cars, with report of cars that have been in use. General discussion. 9500 w. Pro W Ry Club—March 15, 1904. No. 62100 C.

The Construction of Steel Cars. Abstracts of three papers recently read before the Inst. of Civ. Engrs., England. 2000 w. Sci Am Sup—April 2, 1904. No. 61862.

The Lawson Improved Dumping Car. Illustrated description of a type of car used for trestle filling, ballast handling, general construction work, &c. 700 w. Am Engr & R R Jour—April, 1904. No. 61835 C.

Inspection.

Safety Appliances. George Groobey. Extracts from a paper read before the New England R. R. Club. On the number and kind of defects found by the inspectors of safety appliances. 2000 w. R R Gaz—April 1, 1904. No. 61849.

Locomotives.

American Locomotive Building (Der Amerikanische Lokomotivbau). H. Fuchs. Report of a tour of research in the United States, with illustrations and tabulated data of American methods of design and construction. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—March 19, 1904. No. 62200 D.

Consolidation (2-8-0) Locomotive for the Delaware & Hudson. Illustrated detailed description of a wide fire-box engine designed for burning fine anthracite coal. 400 w. R R Gaz—April 8, 1904. No. 62001.

Economical Locomotives. Illustrations and description of a locomotive of novel design, recently tested in Italy, which shows some excellent results in coal economy, as given by Charles R. King in the *Railway Engineer.* 2000 w. Ry & Engng Rev—April 16, 1904. No. 62147.

Four-Cylinder Balanced Compound Locomotives: Atchison, Topeka & Santa Fe Ry. Illustrated detailed description of these new engines, with editorial. 6000 w. Eng News—March 31, 1904. No. 61844.

Heavy Tank Engines with Three Cylinders, Berlin Metropolitan Railway. Illustration, with description of powerful engines for suburban traffic. 800 w. Engr, Lond—April 15, 1904. No. 62344 A.

High-Speed Passenger Locomotives (Lokomotiven zur Beförderung mit Grosser Fahrgeschwindigkeit). W. Wolters. Illustrated descriptions of the successful designs in the recent competitions in Germany. 3500 w. 6 plates. Glasers Annalen —April 1, 1904. No. 62210 D.

Locomotive Frames. A discussion with lengthy introduction by Mr. Vauclain. Ills. 8000 w. N Y R R Club—March 18, 1904. No. 62102.

Michigan Central Pacific Type Locomotive. Illustration and descriptive specifications of six-wheel connected engines for heavy passenger traffic. 800 w. Ry & Engng Rev—April 16, 1904. No. 62146.

Repairs.

Locomotive Repair Records. Describes a new system which is about to be tried on one of the large railroads. A rational system in which engine ton miles is the

We supply copies of these articles. See page 476.

measure of work done. 3700 w. Am Engr & R R Jour—April, 1904. No. 61-836 C.

Smoke-Boxes.

Smoke-Box Action. R. Weatherburn. Discusses the essentials of efficient smoke-box action, and prevailing practice. 3800 w. Engr, Lond—April 15, 1904. No. 62349 A.

Wear.

On the Wear of Tires of Locomotive Driving Wheels and on the Creeping of the Left Hand Rail of Tracks. O. Busse. An account of investigations made on the Danish State Railways. Diagrams. 3800 w. Bul Int Ry Cong—March, 1904. No. 61793 E.

NEW PROJECTS.

Greece.

The Transhellenic Railway (Le Chemin de Fer Transhellénique). A discussion of the proposed railway connecting central Europe with the Piræus, and giving a closer connection with Port Said than the present route via Brindisi; with maps. 2000 w. Génie Civil—March 26, 1904. No. 62214 D.

Peru.

Railway Construction in Peru. Copy of an important project submitted to Congress. 1000 w. U S Cons Repts—April, 1904. No. 62091 D.

Reconnoissance.

Railway Location in the Florida Everglades. William J. Krome. An illustrated article describing an exploration survey through this territory. 1800 w. Eng Rec—April 2, 1904. Serial. 1st part. No. 61807.

Syria.

Railways in Syria. Information concerning railways building and recently completed. 1200 w. U S Cons Repts—April, 1904. No. 62092 D.

PERMANENT WAY AND BUILDINGS.

Construction.

General Rules for Construction Work Illinois Central Railroad. A review of the recently prepared rules on a road which is kept in a condition of high efficiency. 3000 w. Eng Rec—April 23, 1904. No. 62375.

Revised Regulations for Railway Construction in China. Translation of regulations in general. 3000 w. U S Cons Repts—April, 1904. No. 62090 D.

The Southern Missouri Railway. Charles A. Sheppard. An illustrated detailed description of an important piece of railroad construction. 2300 w. Eng Rec—April 16, 1904. No. 62128.

Curves.

Cornu's Spiral as a Transition Curve. D. N. Lehmer. A mathematical demonstration of the application of Cornu's spiral to railroad work. 3500 w. Cal Jour of Tech—April, 1904. No. 61971 C.

Engadine.

The Highest Railway in Europe. Enrico Bignami. Illustrates and describes interesting features of the Albula railway in Switzerland, which reaches an altitude of 5,980 feet. 2000 w. Cassier's Mag—April, 1904. No. 62107 B.

Improvements.

Revision of Grades and Double-Tracking on the Richmond, Fredericksburg & Potomac. Profile showing changes in alinement, with description of other improvements. 1200 w. R R Gaz—April 1, 1904. No. 61851.

Interlocking.

All-Electric Interlocking at Park Junction. Illustrated detailed description of a plant at Philadelphia in which all the functions are worked by electric power. 1200 w. R R Gaz—April 22, 1904. No. 62195.

Electric Interlocking at the New Central Station in Antwerp. L. Weissenbruch. Describes the signal practice on the Belgian State Railway, explaining why the Siemens system was selected for Antwerp, and giving an illustrated description. 7000 w. Ry Age—April 22, 1904. Serial. 1st part. No. 62366.

Schenectady.

The Schenectady Improvements of the New York Central. Plan, sketch map, and description of changes made to avoid high grades and crossings at street level. 1700 w. R R Gaz—April 15, 1904. No. 62117.

Shops.

London and North-Western Carriage Works, Wolverton. Briefly reviews the history of Wolverton since the first locomotive works was established, and gives an illustrated detailed description of the modern works, which cover 80 acres. 2200 w. Engng—April 1, 1904. No. 62069 A.

New Shops of the Terminal Railroad Association of St. Louis at East St. Louis, Ill. Illustrated detailed description of this new plant and its equipment. 1600 w. Ry Mas Mech—April, 1004. Serial. 1st part. No. 61854.

The Wilmington Shops of the Pennsylvania. An illustrated detailed description of this plant which shows advantageous features of equipment and arrangement. 5500 w. Ry Age—April 8, 1904. No. 62036.

Signals.

Block Signals. A. M. Schoyer. Con-

We supply copies of these articles. See page 476.

siders the questions of color for night signals, railways controlled entirely by signals, and one arm signals for blocking two or three blocks. 5000 w. Pro Ry Club of Pittsburg—Feb., 1904. No. 62-103 C.

Terminals.

The Arrangement and Operation of Railway Terminals (Ueber Anlage und Betrieb der Verschubbanhöfe). H. Pallasmann. An examination of the various arrangements of tracks and yards for the shifting of cars and making up of trains at railway terminals. 7000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—March 19, 1904. No. 62246 D.

Underground Brooklyn Terminal of the Long Island Railroad. Plans and description of the terminal at Flatbush and Atlantic avenues. 1700 w. R R Gaz—April 1, 1904. No. 61850.

Train-Sheds.

Experience with Skylight Construction for Railway Train Sheds. A record of experience showing that no form of construction gives enduring service under existing conditions, and that the failure is due to the distortion and destruction of the framework. 5000 w. Eng News—April 21, 1904. No. 62176.

Water Station.

Water Supply at the Halensee Station (Wasserstation auf Bahnhof Halensee). M. Buhle. Illustrating water tower, tank, and pumping plant in the environs of Berlin; capacity 3,000 cubic metres per day. 1000 w. Zeitschr d Ver Deutscher Ing—March 26, 1904. No. 62203 D.

Yards.

The Fairview Yard, Northern Central and P. R. R. Plan and description of improvements made to relieve a serious congestion in the Harrisburg yard. 700 w. R R Gaz—April 15, 1904. No. 62115.

MISCELLANY.

Pennsylvania.

The Beginnings of Railroading in Pennsylvania. From notes by Col. A. K. M'Clure, in the *Philadelphia Press.* Interesting facts from the early history of railroading. 2500 w. R R Gaz—April 8, 1904. No. 62005.

Progress.

Recent Technical Progress on the Railways Belonging to the German Railway Union. Translated from *Zeitung des Vereins.* A summary of the important conclusions in the report of the Technical Committee. 7500 w. Bul Int Ry Cong—March, 1904. No. 61795 E.

STREET AND ELECTRIC RAILWAYS

Alternating Current.

Single versus Multiphase Generators in Alternating Current Railway Work. W. A. Blanck. Considers the relative merits of the two systems, discussing typical cases using one, two, and three-phase generators. 1600 w. St Ry Jour—April 9, 1904. No. 62029 C.

Arnold System.

The Arnold Electro-Pneumatic Railway System. Bion J. Arnold. Illustrated detailed description, stating the principles underlying the system. 4000 w. Sib Jour of Engng—April, 1904. No. 62308 C.

Ashes.

Disposal of City Ashes as an Adjunct of Street Railway Business in Brooklyn. Illustrated description of the arrangements made by the Brooklyn Rapid Transit Co. for the removal and disposal of ashes, street sweepings and rubbish. 3000 w. St Ry Jour—April 23, 1904. No. 62-368 C.

Berlin.

A North-South Berlin City Railway. D. Feldmann. Translated from *Zentralblatt der Bauverwaltung.* Discusses the location of such a line, and the construction. Thinks it is only possible if built sufficiently high to cross over the houses. Map. 2500 w. Bul Int Ry Cong—March, 1904. No. 61794 E.

Birmingham, Ala.

Birmingham Railway, Light & Power Co. Thomas de Granville. An illustrated article describing the system, which is a consolidation of fifteen companies, the track, overhead construction, buildings, rolling stock, &c. 8400 w. St Ry Rev—April 20, 1904. No. 62380 C.

Bogie Motors.

The Position of Motors on Bogie Carriages. B. Pontifax. A discussion of where the motors ought to be fixed, and where bogie cars should be placed on the trains. Introductory to a general discussion. 1200 w. Elec. Engr, Lond—March 25, 1904. No. 61928 A.

Conduit Railway.

A Conduit Electric Railway in London, England. Information concerning this line, with map and illustrations. 3700 w. Eng News—April 21, 1904. No. 62180.

We supply copies of these articles. See page 476.

Current Collecting.

A New System of Current Collecting for Heavy Electric Traction Lines. Henri Somach. Illustrated description of a system devised by E. Huber of the Oerlikon Machine Works, of Switzerland, discussing the points of merit. 3000 w. St Ry Jour—April 23, 1904. No. 62369 C.

Earth Connections.

Protected Earth Connections for Electric Railways (Ueber einen Geschützten Erdleitungsanschluss an Eisenbahnschienen). A. Frey. Illustrating a covered bonding of the rails with a continuous earthing wire. 1000 w. Elektrotech Zeitschr—March 17, 1904. No. 62253 B.

Electric Branches.

Some Operating Data from the Concord & Manchester Branch of the Boston & Maine R. R., Concord, N. H. An illustrated series of articles, explaining methods of dispatching, collecting and registering fares, and the design and equipment of standard cars. 6000 w. St Ry Rev—April 20, 1904. No. 62379 C.

Electric Control.

The Automatic Regenerative Control for Electric Tramways. An illustrated description of a new system of automatic regenerative control worked out by J. S. Raworth, and put in daily service at Davenport, England. 2200 w. Trac & Trans —April, 1904. No. 62080 E.

Interurban.

The Lackawanna and Wyoming Valley Railroad. George B. Francis. Illustrated detailed description of a standard-gauge, double-track, rock-ballasted, third rail electric road on a private right of way, laid with 90-pound rail. Extends from Scranton to Wilkesbarre. 3500 w. Jour Assn of Engng Socs—March, 1904. No. 62312 C.

Los Angeles.

Notes on Los Angeles Railway Company's System. An illustrated description of the features of interest in the rolling stock, car houses, and methods of operating of this company. 3500 w. St Ry Jour —April 9, 1904. No. 62028 C.

Main-Lines.

Developments in Heavy Electric Traction. C. L. de Muralt. Discusses the alternating current systems in use, and the problems connected with the electrification of existing steam roads. 1500 w. R R Gaz—April 15, 1904. No. 62116.

The Electrical Equipment of the Liverpool & South-Port Division of the Lancashire & Yorkshire Railway. Illustrates and describes the equipment of the first English steam railway with electrically-equipped multiple-unit trains. 9200 w. St Ry Jour—April 2, 1904. No. 61875 C.

Single Phase.

Single-Phase Railways. W. A. Blanck. Considers the fundamental characteristcs of various single-phase railway motors, details of line construction, and comparative cost of direct-current and alternating-current systems. Ills. 3500 w. Trans Am Inst of Elec Engrs—Feb. 15, 1904. No. 62188 D.

The Westinghouse Single-Phase Railway System. Clarence Renshaw. An illustrated detailed description of the various features of the system, and its advantages as compared with the present direct-current system. 4000 w. Elec Club Jour—April, 1904. No. 62105.

Stray Currents.

Electrolysis as Caused by the Railway Return Current. Albert B. Herrick. Reviews the fundamental laws governing electrolysis and the remedies that have been most successfully employed. Gives the outcome of investigations covering many of the largest cities in the United States. Ills. 7300 w. St Ry Jour—April 2, 1904. No. 61876 C.

Substation.

The New Dock Street Substation of the Schenectady Railway Company, Schenectady, N. Y. Illustrated detailed description. 2000 w. Elec Rev, N. Y.—April 23, 1904. No. 62371.

Third Rail.

A Protected Sectional Third-Rail System of Electric Traction. Illustrates and describes the Farnham system which not only protects the rail from contact, but distributes the current so that the section will be energized only while the car is passing. 2000 w. Eng News—March 31, 1904. No. 61845.

Tracks.

Rail Joints and Pavements. C. R. Van Buskirk. Read before the Brooklyn Engrs.' Club. Considers modern methods of welding rail joints. 2800 w. Munic Jour & Engr—April, 1904. No. 61874 C.

Some Improvements in Track Construction in Philadelphia. C. B. Voynow. An address before the Phila. branch of the Am. Inst. of Elec. Engrs. An illustrated description of the joints at present used, explaining their advantages, and of the improved methods of holding the rails to line and gage. 3500 w. St Ry Jour—April 2, 1904. No. 61877 C.

Tyrol.

The Mendel Railway (Die Mendelbahn). Oskar Meltzer. A fully illustrated account of the electric and cable railway from Bozen to the summit of the Mendel Pass in the Tyrol. Two articles. 8000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—March 26, April 2, 1904. No. 62247 each D.

We supply copies of these articles. See page 476.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Pacific Coast Miner. *w.* San Francisco.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wiener Bauindustrie Zeitung. *w.* Vienna.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Cranes.

An Elementary Treatise on Hoisting Machinery, including the Elements of Crane Construction and Descriptions of the Various Types of Cranes in Use. By Joseph Horner, A. M. I. M. E. Size, 8 by 5½ inches; pp. xii, 252; illustrations, 228 Price, $3 (7s. 6d.). Philadelphia: J. B. Lippincott Company. London: Crosby Lockwood and Son.

Electric driving has opened up a new era in the crane industry, and hoisting machinery of all kinds has had its field of usefulness widely extended by the application of electric power. The various modifications of construction which have been evolved in correspondence with the change in motive power, are, however, based on the older designs of cranes, and in order to get a thorough grasp of the subject of hoisting machinery, it is therefore necessary to become acquainted with the fundamental principles of design and the practical methods which have been developed through long years of shop experience. In the present book, the "shop" method of treatment has been adopted, and the various types of cranes are handled in a very practical manner. The first part of the volume is devoted to the details of cranes in general, the different parts being described and illustrated with great care. In this way the elements of crane construction are firmly established, and the reader is prepared to apply these principles to the several types of cranes which are described in later portions of the book. Sections are also devoted to the various methods of operating cranes, by hand, steam, water, air and electricity, and to the materials used in their construction. All this, written by a man of long experience in the work of crane construction, makes a very useful book of great practical value.

Drawing.

Compendium of Drawing. Two volumes. Size, 9¼ by 6½ in.; pp. 415 and 483; many plates and illustrations in the text. Price, per volume, $5, per set $8 (until June 1st $3 and $5, respectively). Chicago: American School of Correspondence at Armour Institute of Technology.

Within recent years, the enormous growth of correspondence schools shows that the instruction given by them supplies a real need which is felt by those unable to take a college course and who yet desire to gain knowledge which will help them in their work and will improve their positions. The field of activity of these schools has steadily widened and their courses have been developed by competent instructors, while some institutions have had the benefit of the advice and direction of leading men in the educational profession. In the course of experience, it has been found necessary to prepare special instruction papers to suit the needs of correspondence students and these papers, in some instances, have grown into text books which, among their other good qualities, are concise and eminently practical and go directly to the point, as they are addressed primarily to people who appreciate plain language and clear directions and who have no time to waste. With the increasing excellence of these text books, their scope has been widened, so that now they not only are used by correspondence students, but also find a place as works of instruction and reference for those who have not time to take a correspondence course, and even for those who are studying at a regular engineering college. Among the best of these books is the present compendium, which, while comprising only about a dozen out of nearly ninety instruction papers used in the drawing courses of the American School of Correspondence, contains the essentials for the beginner in mechanical and architectural drawing and starts him in the right direction. The information is given in a clear, direct manner and is profusely illustrated by figures in the text and many plates. The two volumes comprise the following principal parts, each prepared by an authority in his line: Mechanical drawing; shades and shadows; perspective drawing; pen-and-ink rendering; architectural lettering; working drawings; mechanism; machine design; sheet-metal-patter drafting; and tinsmithing. Attached to each section are examination papers, so that the student is enabled to test his knowledge as he goes along. Owing to the range of subjects, as well as on account of the way in which they are treated, this work will be found

useful not only by the beginner, but also by the advanced student and the professional draftsman.

Framed Structures.

The Theory and Practice of Modern Framed Structures. By J. B. Johnson, C. E., C. W. Bryan, C. E., and F. E. Turneaure, C. E. Eighth Edition. Size, 11 by 8½ in.; pp. ix, 561; plates, 50; figures, 451. Price, $10. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Bridge practice is developing so rapidly and new varieties of framed structure, notably the skeleton building, are coming into such general use, that a new edition of this standard work, partly rewritten and brought up to date, is very welcome. Unfortunately, its chief author, Prof. Johnson, whose untimely death was such a great loss to the engineering profession, which is indebted to him for founding *The Engineering Index*, for writing several other engineering works and for his promotion of sound engineering education, did not live to see this treatise in its latest form, but his co-authors have done their part in a most satisfactory manner. The theoretical portion of the book has been so modified as to best meet the needs of students and beginners, although the professional engineer has been by no means lost sight of. The latter class of readers will be perhaps most attracted by the chapters on structural designing, some of which, such as that on the aesthetic design of bridges, which subject is happily beginning to receive more attention in the United States, and that on tall-building construction, are of special interest at the present time, as is also an appendix by Frank W. Skinner on American methods of bridge erection, adapted from a lecture delivered at Cornell University. The volume is profusely illustrated with figures in the text and with plates containing details of structures and views of some of the notable bridges in Europe and America. Altogether the work will prove a most valuable one, both for the use of schools and for engineers in professional practice.

Friction.

A Treatise on Friction and Lost Work in Machinery and Millwork. By Robert H. Thurston, M. A., LL. D., Dr. Eng'g. Seventh Edition. Size, 9 by 6 in.; pp. xi, 430; figures, 77. Price, $3. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

Of the great amount of work done by the late Professor Thurston, by which he made the whole engineering profession his debtor, those parts relating to friction and lubrication are among the most valuable. He had a thorough knowledge of the history of engineering, and possessed the happy faculty of clearly analyzing the work of other engineers and systematically setting forth their conclusions, while, in addition, he enriched many branches of engineering with his own researches. These various aspects of his genius are well shown in the present work, which has progressed through successive editions, in order to meet a steady demand and to keep pace with the advances in engineering, until this latest one, which, unfortunately, will also be the last revised by his own hand. The larger portion of this book treats of the theory of friction, lubricants and lubricating apparatus, the testing of lubricants and experiments on friction, and other matters relating to the technical side of the subject. But there is also a chapter on "The Finance of Lost Work and the Valuation of Lubricants," which shows, both by analysis of principles and by practical examples, that it is the sum of the costs of wasted power and of lubrication, and not merely the cost of the lubricant, which is to be minimized. The insignificance of the cost of lubrication compared with the power that can be saved by reducing friction clearly indicates the importance of using the lubricant best adapted to any particular purpose, without regard to its price. A new chapter has been added, giving a summary of recent investigations in friction and lubrication, and containing, among other things, an account of Lasche's studies of bearings for high speeds, preliminary to the Zossen high-speed electric railway experiments. In the course of the years since the first edition of this work was issued it has had a strong influence in promoting a sounder knowledge of the principles of friction and lubrication and in improving practice, and the author had the satisfaction of living to see much of his pioneer work confirmed by followers in his steps and his early views accepted by the engineering profession.

Health Board.

Thirty-Fourth Annual Report of the State Board of Health of Massachusetts. Size, 9 by 6 inches; pp. li, 623: Boston: State Board of Health.

The high state of civilization and public spirit in Massachusetts is well shown by the activities which these reports of the State Board of Health describe, as well as by the reports themselves. The present volume, for 1902, has its greater part devoted to water supply and sewerage, under which heads are given advice to cities and towns in reply to inquiries addressed to the Board of Health; the examination of water supplies, and experiments on the purification of sewage and the water filtration and bacteriological studies at the famous Lawrence Experiment Station. There are also reports upon food and drug in-

spection, diphtheria antitoxin, diphtheria cultures, examinations for tuberculosis, typhoid fever and malaria, statistical summaries of disease and mortality and a report on the health of towns. An index completes a public document which has a wide sphere of usefulness and does credit to the Board and the State issuing it.

Railroad Earnings.

The Earning Power of Railroads. By Floyd W. Mundy. Size, 7½ by 5 in.; pp. 244. Price, $1.25. New York: Metropolitan Advertising Co.

Balance sheets alone do not supply all the information desirable for an intending investor in railroad securities. To get a complete idea of the value of such stocks and bonds, a careful investigation should be made also of a road's physical condition and of the possible development of traffic. But a careful analysis of reports, with an indication of the real meaning of the various items, will be a great help, and it is the object of the present book to give the statements issued by the principal railroads of the United States and Canada, together with the interpretation thereof. There are tables showing the earnings, capitalization, mileage and other statistics of 112 railroads, with notes which explain and amplify these reports. Besides the statistics, which occupy the body of the book, there are introductory chapters which discuss the true significance of maintenance expenses, conducting transportation and general expenses, fixed charges, the "operating ratio," and the various other features of railway accounting, so that the investor in railroads, as well as the student of railroad economics, can read the reports which are now issued with considerable uniformity by the railroads of the United States, under the direction of the Interstate Commerce Commission, with understanding and profit.

Transformers.

The Alternating-Current Transformer. By F. G. Baum. Size, 7½ by 5½ in.; pp. 195; figures, 122. Price, $1.50. New York: McGraw Publishing Co.

While the fundamental principles of transformer construction are the same as they were in the early days of alternating-current engineering, the details of design have improved vastly, so that there has been a great reduction of iron and copper losses and the regulation is far better. More attention is also given to what may be called the auxiliary features of transformer design, but which are of the greatest importance in securing efficient operation, such as insulation and cooling, but as was brought out at a recent meeting of the American Institute of Electrical Engineers, there is still much room for improvement in this direction, and with the increasing voltages which are demanded in long-distance transmission work, such improvements will have to be made. In the present work, which originated from a course of university lectures, the theory of the transformer is set forth in a clear and orderly manner, and enough of current practice is described to give the reader a very good idea of that side of the subject. After the introductory part of the book, the theory of the transformer is studied from the point of view of the changing magnetism, rather than of the varying currents directly, and there are chapters on the graphical representations of pressure relations, regulation and efficiency. Testing forms the subject of one chapter, and the systematic design of transformers is laid down in another. Other chapters are devoted to circuit regulators, constant-current transformers, series transformers, compensating voltmeters, and connections of transformers for single-phase and polyphase circuits. The last chapter describes various commercial types of transformers, while an appendix contains some extracts from the rules of the U. S. National Board of Fire Underwriters. Altogether, the book gives a very good account of its subject, and will be a useful one for the engineer as well as for the student.

BOOKS RECEIVED.

Practical Laws and Data on the Condensation of Steam in Covered and Bare Pipes. By Charles P. Paulding. M. E. Price, $2. New York: D. Van Nostrand Company.

Proceedings of the First General Convention to Consider the Questions Involved in Mosquito Extermination. The National Mosquito Extermination Society, H. C. Weeks, Sec'y, Bayside, L. I., New York City.

Towers and Tanks for Water-Works. By J. N. Hazlehurst. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The Non-Metallic Minerals, Their Occurrence and Uses. By George P. Merrill. Price, $4. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Architects' and Engineers' Handbook of Reinforced Concrete Constructions. By L. J. Mensch. Price, $2. Chicago: Cement and Engineering News.

Naval Architecture. By Prof. Cecil H. Peabody. Price $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Engineers' Arithmetic. By Fred. H. Colvin and Walter Lee Cheney. Price, 50 cents. New York: The Derry-Collard Co. London: The Locomotive Publishing Co., Ltd.